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PHYSIOLOGY AND THE COMMUNITY

ALTHOUGH physiology has been recognized as the basis of medicine for many decades, and, therefore, has been accepted as one of the chief subjects of study for medical students, it is surprising how little has been done in the teaching of the subject elsewhere and with other aims and purposes.

Many years ago, that great teacher of physiology, Sir Michael Foster, laid down various sound principles for the wider teaching of the subject at Cambridge. He hoped that students who were not necessarily taking up medicine would read it in a broader manner so that they should perceive its relations with other sciences and should take an interest in its ancillary subjects.

It is appropriate that in her presidential address to Section I (Physiology) of the British Association at its Dundee meeting, Prof. Winifred Cullis should make a plea for the wider teaching of physiology in its relation to the needs of the community. During a long life devoted to the active teaching of and research in physiology, Prof. Cullis has seen her subject in many aspects. Not only does she know of the fundamental necessity of first-class physiology teaching in all medical schools, but also in the role of examiner she has seen the effect of its neglect in many teachers' training and domestic science colleges. Moreover, in her lecture tours in many parts of the world, during the War and since, she has perceived both the enormous interest which is aroused by her subject and the woeful ignorance of it, even among otherwise cultured people.

Everyone, whether he or she is interested in the sciences or not, has a body, on the health of which depends in large part the happiness and effectiveness of the individual and even his or her continued existence. We all should be students of the healthy body. Such knowledge of healthy living, derived from the sound principles of the functioning of the normal body, will not lead to a state of valetudinarianism on one hand, nor to the appearance of a race of amateur medical men on the other. Much is being done in the field of health education, and, as results show, in this matter we are fighting a winning battle.

The local and central health services, with their considerable staffs of experts, and the various health education councils such as the Central Council for Health Education and the British Social Hygiene Council, would be helped in their work by a wider teaching of physiology in its elementary stages in the schools and training colleges. It is only too easy to distinguish between those students of training colleges whose work has been properly reared on a basis of the sound teaching of the biology of man and those who have committed to memory the superficialities of the hygiene primer. "The proper study of mankind is man", and no man can consider himself to have a full and liberal education unless he has included in it some knowledge of his own physical and mental nature and processes, together with the conditions which should secure their efficient working and interaction.

The imagination of the public has been captured by accounts of such drugs as the sulphonamides, penicillin and streptomycin. Fantastic notions concerning the mode of action of such substances are prevalent, and it is in the public interest that their indiscriminate use be prevented, even when supplies are available. Misleading stories concerning the treatment of hæmolytic disease of the new-born (erythroblastosis fœtalis) have appeared in the Press and have had wide currency. There is incredible gullibility concerning the value of worthless or even dangerous patent medicines, which sell for millions of pounds each year, and there is considerable public ignorance and superstition concerning sun-bathing, infectious diseases, indigestion, the use of laxatives, eye-strain, muscular development, kidney trouble, and the use of cosmetics and toothpastes, to mention only a few topics taken at random. The wider correct teaching of the elementary biology of the human body and its normal working would go far to overcome these troubles, and would sooner or later lead to a sounder attitude towards a healthy body and its mind.

As a subject, physiology is rich in human values, in addition to the obvious value of its relation to man and his healthy living in his environment. The history of some of the fundamental researches in physiology is so recent that it is scarcely necessary to mention them. The work of such men of science as Banting and Gowland Hopkins is known to a great many who have only the vaguest ideas of the significance of such a figure as Dalton in the story of science.

Physiology is enriched by its relations with other branches of science and in turn it enriches them. The discovery and preparation of many isotopic varieties (whether radioactive or not) of practically all the chemical elements have put into the hands of the physiologist a new instrument of research of considerable importance. The research neurologist of to-day could not go far without modern valve amplifiers and cathode ray tubes. Chemistry has made such contributions to physiology in recent years that not very long ago, in some of our universities, there was a tendency to find the subject engulfed in the great mass of biochemical researches which were then in spate.

In its turn, physiology has much to offer. It is often a useful focal point for the other aspects of biology. Unless the modern psychologist insists upon confining himself to the purely philosophical aspects of the conception of mind, he must, to an increasing extent, use the physiological discoveries made in recent years in the fields of neurology and endocrinology.

The subject of dietetics is of paramount importance for healthy growth and life. Its relation to healthy and virile mental functions has never been properly estimated. These and related problems have a particular significance during the present difficult period. Physiologists know what is required of food in the matter of the various needs of the body, and they know what each kind of food should do. There is still an idea, which has been given great publicity, that minimum rations in relation to bodily needs can be measured by their calorie values, that is, the amounts of heat or equivalent energy which they will produce when they are perfectly oxidized by the body. A reliance on total daily calorie value (even though this is adequate, and often it is not) as an estimate of the physiological value of the rations may lead to physical disaster, or at any rate to some degree of malnutrition with its sequelæ. The physiologist knows the value of foods with respect to their *qualities*, and he can give advice concerning the value of various articles of diet such as fruit and vegetables which are not included in rationing schemes. It must be regarded as a crime to do anything which will restrict the free flow of supplies either by forcing up prices or by destroying, at any time of the year, those foods which balance the 'calorie diet'.

The teaching of physiology is related to that of bacteriology and the control of micro-organisms, whether useful or pathogenic. Physiology also provides one of the two important bases of sound sex teaching, the need for which is at last adequately recognized.

The chief need at present (and it will be for many years) is for more teachers. The supply of science students who can specialize in physiology in the universities and training colleges must increase in the future. It is to be hoped that many biology students who are not going to read medicine will give some thought to the importance of human biology.

At present a considerable amount of good broadcasting to schools has been done with elementary physiology as its theme, and a number of well-made health films on a sound biological basis are available from the Central Film Library and elsewhere.

Teachers of biology in the secondary modern schools and lecturers in training colleges who are largely responsible for their own syllabuses and methods could do work which would have the utmost value to the community by thinking of the physiological processes of the healthy body as a means of integrating their other work. When there is a fuller realization of the value of qualifications in physiology in many walks of life, there will be a larger body of students who will read this subject as the chief part of their science degrees.

RESEARCH IN INDUSTRY

Co-operative Research in Industry

By Dr. D. W. Hill. Pp. 147 + 3 plates. (London: Hutchinson's Scientific and Technical Publications, 1947.) 10*s.* 6*d.* net.

IN the series of conferences and reports during the last few years which have been planned to encourage the expansion of research in industry, it was natural that the main stress should be laid on the past achievements of research. Exhortation was rightly based on a description of such achievements and the methods by which they were obtained; but although the different ways in which research can be organised were usually indicated there was rarely any critical appraisal of the alternatives or consideration as to whether the same or greater results might have been obtained with less effort in some other way.

This critical review of past experience is exactly what one expects, however, in such a book as the present, and unfortunately Dr. Hill gives us little more than did Sir Frank Heath and A. L. Hetherington in their survey, "Industrial Research and Development in the United Kingdom", last year. Dr. Hill's survey, it is true, is not limited to the United Kingdom. He has brief descriptive accounts of co-operative research elsewhere in the British Empire and also in the United States, and his book includes much information which for the most part was previously scattered and not so conveniently accessible in one volume.

Dr. Hill's survey covers, however, not merely the research associations of the Department of Scientific and Industrial Research but also the research stations of that Department, as well as the activities of the Medical Research Council and the Agricultural Research Council: apparently any research carried out by a Government department is co-operative research in his definition. None the less, he brings out well enough the characteristic pattern of the research association in Great Britain as contrasted with the industrial fellowship pattern of the United States. Dr. Hill refers, indeed, to the departure from that pattern represented by the attempt in 1922 to establish industrial research fellowships at the University of Bristol; but he goes no further than to suggest, in addition to the extension of the research associations now in progress, that a whole-hearted experiment on fellowship laboratory lines might be undertaken.

What is lacking is exactly that critical analysis of past experience and comparison of the methods and results obtained by different systems which should be undertaken as a matter of urgency before we are irrevocably committed to large developments. Uneasiness about the research association movement has been freely voiced at recent conferences, and at a recent conference in Glasgow a strong plea was made for an experiment with the Mellon Institute type in Scotland. The absence for more than eight years of any full report from the Department of Scientific and Industrial Research is a further hindrance to appraisal of that movement, and such a report seems clearly demanded in the public interest before its strained resources are too heavily committed to expansion which conceivably may not offer the maximum return.

In his final chapter, "The Future of Co-operative Research", Dr. Hill shows himself aware of some of the dangers of co-operative research and indicates some of the weaknesses and limitations of the research associations. If he appears diffident in his criticism he displays the facts admirably, and sometimes underlines the text from which others might preach the sermon. It is true that this chapter might have dealt more fully with the current problems of money, scientific man-power and the incorporation of research into administrative practice, which are what call for discussion at the moment. Dr. Hill might have probed more closely, too, into the meaning of co-operation. There is real danger that payment of a subscription to a research association may, in fact, prove a sedative and not a stimulus, and mask the absence of real co-operation or the outlook, initiative and enterprise which find expression in research.

Dr. Hill does, indeed, conclude an admirable account of two successful American institutions, the Institute of Paper Chemistry and the Mellon Institute, with the suggestion that the principles upon which they operate might well repay study in Great Britain. He emphasizes the association of the former with Lawrence College and with teaching, and also its location in a compact paper-manufacturing area—a feature in striking contrast with such proposals of the Department of Scientific and Industrial Research as that for the conduct of coal research at Leatherhead. For all that, he leaves to others the close analysis and comparison of American and British experience which might be so fruitful, just as he passes over the question of national co-operation and the implications of proposals like those to be found in the reports of the Board of Trade Working Parties for Cotton and for Wool for advisory councils covering groups of related industries.

Nevertheless, in spite of such limitations and a tendency to confuse fundamental research with the fact-finding research of industry, Dr. Hill has provided a useful and welcome review. This survey is balanced and sufficiently objective to stimulate the bold, authoritative and comprehensive analysis of the whole question which is imperatively needed.

R. BRIGHTMAN

STRAIGHTFORWARD INSTRUCTION IN STOCK-RAISING

Raising Livestock

By Walter H. Peters and Prof. George P. Deyoe. Pp. x + 519. (New York and London: McGraw-Hill Book Co. Inc., 1946.) 17*s.* 6*d.*

ORGANISATIONS to encourage the interests of the young entrant to farming have recently sprung up in many parts of the world. Their membership has expanded at different rates in the various countries—successful growth possibly being related to the aptness of the educational content of their activities. Whatever the precise form of organisation—young farmers' clubs, 4 *H.* clubs, vocational training—there has been a general stimulus to an increasing output of literature. Much of this has been instilled by high motives and good intentions to impart instruction of 'sound principles' to the coming generation of agriculturists; and the young farmer has been given a liberal choice of handbooks, leaflets, bulletins and elementary texts from which to gain an insight into the science and practice of his vocation.

But it is questionable how well, or usefully, the obvious educational opportunities have been seized. In the field of animal production, at least, it is doubtful whether paraphrase of the more advanced literature into simpler terms—often extremely salutary in itself—gives more than a superficial acquaintance of ideas and an easy patter, when understanding and appreciation are needed. Nor does the traditional approach, along the lines of 'better feeding, better breeding, and better management', seem to achieve any greater success—it usually involves either too much effort taken to break down and then rebuild upon the older ideas or too much dogmatism and repetition without clarity. Any new attempt to meet the demands and needs of this enlarging group of young farmers for clear, balanced, and reasonable instruction can, therefore, be justifiably regarded according to its method as well as its matter.

"Raising Livestock" is written in the light of American experience and knowledge. Its aim "is to provide up-to-date information on raising live-

stock". It "is intended primarily for students of vocational agriculture and other youths on farms and ranches who are assuming new responsibilities in raising livestock". These purposes are well served. One author is skilled in animal husbandry, the other in education. Their joint authorship provides a model of a sensible, direct and logical exposition of principles and practices. The whole field is adequately covered, from the broad economic and business aspects, through judging, feeding, housing and handling livestock, the maintenance of health, breeding and the intelligent use of records, to marketing stock and products, and preparing and processing the products for use (including quick-freezing). The book is profusely and aptly illustrated; there is a useful index and, in addition, an annotated list of films and film-strips suitable as visual aids. Few errors have been noted, though that on p. 344, which implies that selected daughters should be used in computing a sire index, is regrettable, and the index given is for Sire A, not B; also, p. 288, it would be scarcely fair to accept for British conditions that pasture rotation offers the only control measure for liver fluke in sheep.

In their preface the authors express the hope that the book "should also be useful to adults . . . who are interested in securing better returns from livestock enterprises". For British readers this could well be extended to those who are concerned with the presentation of instruction in the many aspects of animal production, at all levels of the existing agricultural education system.

J. E. NICHOLS

PIEZO-ELECTRICITY

Piezoelectricity

An Introduction to the Theory and Applications of Electromechanical Phenomena in Crystals. By Prof. Walter Guyton Cady. (International Series in Pure and Applied Physics.) Pp. xxiii+806. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 45*s*.

IN 1921 W. G. Cady proposed the use of quartz vibrators piezo-electrically excited at their resonance frequency for stabilizing radio installations, and thus originated the new industry of piezo-electric engineering which has employed thousands of workers on the manufacture of millions of stabilizers and oscillators. Cady had been interested in piezo-electricity before, and had studied in particular the piezo-electric properties of Rochelle salt, and ever since, he and his school at Wesleyan University have never ceased investigating the subject. This treatise, long awaited by his numerous colleagues and friends, embodies the experience not only of the author and of his school, but also of other workers in the field, and will earn him the gratitude of all interested in crystal physics.

The book starts with a relation of the discovery of pyro- and piezo-electricity and of the parts played by the brothers Curie, by Kelvin and by Voigt in the study of the phenomena and the development of theory. From the outset the enthusiasm of the author for his subject is evident, and may account in a large measure for the thoroughness and elegance of presentation. A concise yet adequate introduction to crystallography is followed by chapters on crystal physics, including elastic and dielectric properties, and a treatment of thermodynamic potentials, which are used afterwards in the exposition of the theory of piezo-electricity. Valuable formulæ and tables for transformation to rotated axes are given, and indeed wealth of data and references are special features of the work. From a critical survey of all available experimental data, Cady has assigned "most probable values" to the elastic, dielectric, piezo-electric and other constants of quartz, tourmaline and Rochelle salt. This evaluation must indeed have been a laborious task; but it will prove of immense value to all workers in this field.

In the theory of piezo-electricity given by Voigt, piezo-electric strain is expressed in terms of applied electric field. Measurements show, however, that in the case of Rochelle salt the quotient of strain to field varies greatly with temperature, as also does the permittivity, whereas if the piezo-electric strain is expressed in terms of electric charge or electric displacement, the quotient is almost independent of temperature. Although Cady remarks that experimental results taken by themselves lead to the expression of piezo-electric strain in terms of displacement, "nevertheless, one should not confuse that which is most easily measurable with that which is most fundamental; and if the proportionality of stress with field has to be abandoned, it appears fundamentally more logical to assume proportionality with polarization than with a parameter that involves both P and E". Since, however, it is always charge rather than polarization which is observed, might it not be held that expression in terms of charge is preferable?

As was to be expected from the author, the chapter on the piezo-electric resonator bears the stamp of thoroughness. Cady has long been interested in the effect of air gap on response frequency, to which he devotes a considerable proportion of this and subsequent chapters, but certain discrepancies between measured and predicted effects of gap still appear to defy explanation. Various types of cut designed to yield vibrators of negligible thermal coefficient of frequency are described, and the account of the piezo-electric valve-maintained oscillator, with clear, concise physical explanations of stabilizer and oscillator action, is a welcome contribution to the subject.

The Seignette electrics, of which Rochelle salt is the best known member, stand in relation to quartz or tourmaline very much as iron to paramagnetic substances, and Valasek, Kurchatov, Fowler, Mueller and Cady have worked on interaction, polarization and other theories in an endeavour to explain observed phenomena. The part of the book devoted to this aspect is possibly the least easy to read, but the reason may lie in the inherent complexity of the subject. The same reason may account for the impression left that the explanations given are very imperfect, and that, as with ferro-magnetism, much experimental and theoretical work remains to be done.

There are numerous lists of references, the bibliography at the end has more than 650 entries, and the data interspersed throughout the text will be found most valuable; for this reason, and because of the excellence of the general treatment of piezo-electricity, the book will be in demand in every scientific library. The printers are to be congratulated for the presentation, while the paucity of misprints bears witness to the meticulous care taken by all who have been concerned in the preparation of an excellent treatise.

P. VIGOUREUX

The Experimental Study of Structures

By Prof. A. J. S. Pippard. Pp. viii+114. (London: Edward Arnold and Co., 1947.) 9s. net.

THIS book is based on a course of lectures given by Prof. A. J. S. Pippard to teachers in technical colleges on the use of models in the teaching of the theory of structures. After a discussion of the function of experiments in structural teaching and research and a brief summary of certain fundamental theorems, Prof. Pippard limits himself, in spite of the rather sweeping title of the book, to a description of the equipment and teaching programme of the excellent Model Structures Laboratory at the Imperial College. Chapters follow on direct experimental methods, applications of the reciprocal theorem, strain energy and moment distribution methods, experiments on voussoir arches and experiments with sand.

Prof. Pippard makes out a very strong case for the use of models in teaching, but many will feel that he overstates it when he suggests that in the absence of the experimental approach there is a tendency "to regard the subject as merely one more course of lectures in mathematics". There is very little doubt that demonstrations add greatly to the entertainment value of a lecture and the popularity of a lecturer, but by their very nature they are bound to falsify the behaviour of real structures, and may easily mislead.

The chapter on Begg's method and the method of large deflexions should make these valuable tools of the structural designer much more widely known. It is surprising that no mention is made of the creep properties of celluloid, which is the model material used. The fact that celluloid has an instantaneously constant value of Young's modulus is an essential condition for the success of this method of analysis.

Prof. Pippard concludes his book with a number of practical hints which should prove most useful to all those who will be encouraged by it to teach experimental methods of structural analysis in universities and technical colleges. E. K. FRANKL

Mathematical Aids for Engineers

By Raymond W. Dull. Pp. xii + 346. (New York and London: McGraw-Hill Book Co., Inc., 1946.) 22s. 6d.

THE necessity for this book is well stated by the author when he declares in the preface: "There have been so many new engineering developments in the last few years that engineers and those preparing to become engineers are seeking mathematical aids to meet the situation". Herein lies one of the prime causes for the modern demand that mathematics must become more practical. With the rapid growth of science and the advance in all branches of engineering, the need for the intelligent application of mathematical principles has become urgent. Unfortunately, such application cannot be easily culled from the usual school and college text-books, for they have much too great a bias for theory and, as a consequence, new books are constantly being called for which lay special stress on the practical aspect of the subject. Such books are no longer of the former rule-of-thumb type, nor of the older practical mathematics brand where the treatment had very little, if any, theoretical background; but, to provide for existing needs, mathematical fundamentals are served up with just as much theory as will make them intelligently palatable.

The present work consists of 346 pages of very practical text involving 28 chapters. There are interesting and instructive discussions on scales, logarithms as an implement, organic growth, circles as tools, vectors and the elements of mechanics, and complex numbers, with a brief revision of the fundamentals of the calculus up to practical linear differential equations.

The text is well written and arranged, profusely illustrated both with clear diagrams and practical problems fully worked out, but there are no exercises for the student to tackle. This seems a grave defect, presumably because the book is regarded as a work of reference, for the usefulness of a really excellent volume would have been considerably enhanced had the reader been provided with some good hard nuts to crack in addition to those already served up for him. A short index is provided, but there are no tables.

Science and Reality

By T. Bedford Franklin. Pp. vi+56. (London: G. Bell and Sons, Ltd., 1947.) 3s. 6d. net.

THE remarkable thing about this little book is that it has, in fact, been written. It is almost inconceivable that such would have been the case a few decades ago. The setting is a duologue between a man of science and Mr. X: the latter, by the way, is the late Sir Arthur Eddington's friend who knew what matter was. In a very nicely adjusted game of cut and thrust (much more charitable than usual) the crucial issue of materialism versus axiological precept is faced anew. The result is not altogether likely to convince where conviction is undesired (indeed there is little 'compulsion' anywhere), but the upshot is nevertheless indicative of humility, and therefore perhaps of progress towards a solution, or a partial solution, of mankind's greatest and deepest needs.

There are many quotations from leading scientific and philosophical writers: excellent as these extracts are, they tend on balance to weaken the argument. The author does not explicitly use them, and they resemble texts from which the preacher plans to escape as soon as possible. This, of course, is a well-known technique; but the pages before us are robust enough to do without it.

The author's description of the usual biological theories could scarcely be bettered, though he is a little hard on their adherents when he expects them to produce precision without mechanism. This may indeed have to be done, but the day is not yet. Finally, one of the outstanding scholars whose work is quoted is inadequately described, not once but twice. Otherwise, the production is admirable.

F. IAN G. RAWLINS

Atlas of Bacteriology

By Dr. R. Cranston Low and T. C. Dodds. Pp. vii + 2 + 168 plates. (Edinburgh: E. and S. Livingstone, Ltd., 1947.) 32s. 6d. net.

THIS is a companion to text-books on bacteriology and intended primarily for use by medical students. Organisms and cultures have been reproduced mainly from actual colour photographs, with water colours when that process was unsatisfactory. The results are, on the whole, very good and a credit to the photographer, Mr. T. C. Dodds. Very brief descriptive notes accompany the illustrations. The book should be a useful visual aid to the study of bacteriology. JAMES MARSHALL

SEISMIC ASPECTS OF THE HELIGOLAND EXPLOSION

By P. L. WILLMORE
Department of Geodesy and Geophysics, Cambridge

THE Heligoland explosion of April 18, 1947, was planned by the Navy for the purpose of destroying the German fortifications on the island, and as a convenient method of disposing of surplus ammunition from the British zone of Germany. From the scientific point of view, it was realized that the detonation of some 4,000 tons of high explosive would provide an almost unique opportunity for the collection of seismic and meteorological data on a continental scale.

To the seismologist, the advantage of a controlled explosion over a natural earthquake is that when the time and place of detonation are known in advance, it is possible to dispose apparatus to the best advantage and to use a higher recording speed than is usual for continuous operation. A further gain arises from the fact that the whole of the data can be used to determine the travel-time curves.

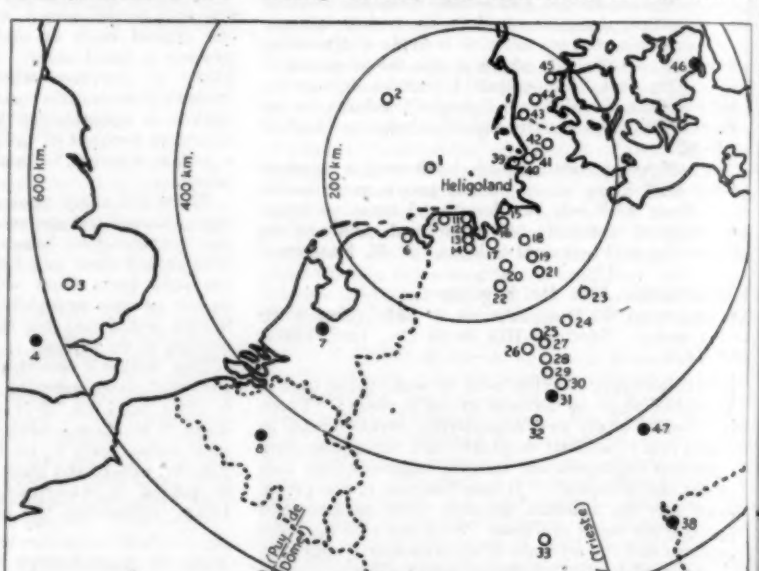
Early in 1946, a joint committee of the Royal Society and Ministry of Supply started to consider the possibility of firing charges of sufficient size to give reliable data on the travel times of the near earthquake pulses, but the damage radius of such charges was sufficient to eliminate all the available sites in England. In July of that year, it was announced that a number of large charges would be fired in Germany, some with the object of destroying fortifications, and others in tests on the safety of ammunition dumps. The Research Branch of the Control Commission agreed to assist the Committee in arranging the necessary observations. The greater part of the work was done by the Göttingen Geophysical Institute and by the Geologisches Landesamt in Celle, with some assistance from Britain.

The first series of explosions took place on the surface of the Luneburger Heide near Soltau. The military authorities in charge of the operations willingly agreed to assist by firing the charges within a few seconds of an agreed time. Special time-signals were broadcast over the German network to synchronize the chronometers of the field parties, and by using instruments with a recording speed of several centimetres per second, the error in reading a sharp arrival was reduced to a few hundredths of a second.

It was found possible to maintain up to nine parties in the field, and a total of ten explosions was observed. Unfortunately, the cushioning effect of the soft sandy deposits was such that the shock of a 40-ton charge could only be traced for about 50 km. A charge of 12 tons of high explosive stored in a U-boat pen at Kiel was observed up to about the same distance. The results will probably throw light on the structure of the North German Plain at depths greater than those reached in the war-time search for oil, and should help to provide local corrections for the Heligoland stations.

The Heligoland explosion justified a much more ambitious programme, which could scarcely have been completed without the enthusiastic co-operation of H. L. P. Jolly and other members of the Research Branch. A circular to permanent seismological observatories within 1,000 km. of the island produced a gratifying response, and a number of stations made special arrangements for recording. In addition to these, the stations at Copenhagen, De Bilt and Prague organised field parties in their respective countries.

In Germany, twenty-three stations were operated by teams from the Göttingen Geophysical Institute, the Seismos Company, and the Gesellschaft für praktische Lagerstattenforschung. The Admiralty Mining Establishment announced its intention of



STATIONS OBSERVING THE HELIGOLAND EXPLOSION
Full circles represent permanent observatories; open circles, field stations

1	H.M.S. *Nepal*	11	Minsen	21	Söhlingen	30	Leverhausen	39	Poppenbull
2	Trawler *Astrid*	12	Wurfreihe	22	Bassum	31	Göttingen	40	Warmhörn
3	Cambridge	13	Ellens	23	Bokel	32	Melsungen	41	Westerholz
4	Kew	14	Benshohe	24	Immensen	33	Würsburg	42	Jübeck
5	Esens	15	Altenwalde	25	Benthe	34	Strasburg	43	Mogeltonder
6	Spijk	16	Bremerhaven	26	Hameln	35	Stuttgart	44	Tislund
7	De Bilt	17	Brake	27	Marienburg	36	Donaworth	45	Kolding
8	Uccle	18	Bevern	28	Eimsen	37	Trieste	46	Copenhagen
9	Paris	19	Volkensen	29	Naensen	38	Cheb	47	Jena
10	Puy de Dôme	20	Bremen						

sending two ships with hydrophones capable of detecting the arrivals of seismic waves under the North Sea, and the present writer took out two further hydrophones in the hope of finding suitable shipping facilities in Germany. The Hydrographer in Hamburg found four Germans to volunteer for the operation, and Fisheries Control consented to the apparatus and observers being placed on North Sea trawlers. Three days before the explosion, we heard that only one ship, the *Astrid*, would be available, so the second party was placed on the Elbe I lightship at a distance of fourteen miles from the island.

Finally, ten two-component horizontal seismographs, sent over by the U.S. Navy, were distributed along a line from Bremerhaven to North Italy. Owing to a breakdown of liaison, we and the Americans remained unaware of each other's arrangements until shortly before the explosion, when a friendly but slightly rueful discussion showed that our independent arrangements had gone too far to be reorganised at that stage. As we had each provided an adequate number of near stations, we were left with a rather heavy concentration of effort between Göttingen and the coast (see accompanying map).

The activities of the field parties were co-ordinated by a series of broadcasts in the B.B.C. European Service. After two rehearsals, the explosion was preceded by a 'stand-by' warning. A series of pips at one-second intervals was recorded on the seismograph films, and avoided the need for separate chronometers at the field stations.

In handling the demolition arrangements, the Navy was faced with the problem of firing groups of explosives in two gun batteries near the surface of the island, in the U-boat pens to the south-east, and in an extensive set of tunnels about 130 ft. below the surface. The total net weight of explosive was 3,997 tons, of which 2,643 tons were contained in the lower galleries.

The possibility of firing the charges in separate groups was considered, but the chances of premature explosion and of damage to parts of the tunnel system led to the adoption of a plan for simultaneous detonation. The explosion was initiated by means of electric detonators, each incorporating a one-second pyrotechnic delay to enable the electric circuits to complete their work before the commencement of the explosion. The detonators fired explosive junction boxes, which were connected by 'Cordtex' links of uniform length to local boxes in the storage galleries. Primers were fitted to at least one charge in every six, and were connected to each other and to the local junction boxes by a network of 'Cordtex'. Rapid initiation was ensured by connecting the main junction boxes by a 'Cordtex' ring-main, so that any one detonator would fire the whole system. The electrical firing circuits were all duplicated, and were initiated simultaneously by a radio transmission from one of the control ships, and by a signal sent along a special submarine cable.

To determine the instant of detonation, the British Forces' Network installed two German transmitters on Heligoland, and recorded their output at the listening post at Altenwalde. Although each transmitter was seated on a 50-lb. explosive charge linked with the main 'Cordtex' system, they continued to give some output for three seconds after the appearance of violent fluctuations on the record. The time of the final cessation of output is inconsistent with the seismic data and with the expected time of firing. It has therefore been assumed that the small charges misfired, and the onset of the fluctuations has been taken as the instant at which the transmitter was struck by the blast of the main explosion.

Readable seismograms were obtained from all except five of the field stations and from permanent observatories so far away as Puy de Dôme (998 km.). To the north and west, reception was disturbed by severe microseisms, and no arrivals are discernible on records from Norway, northern England and Scotland. Records from the American stations have not yet been received, but it is understood that results were obtained as far as Trieste. At Göttingen, special care was taken to stop traffic on the road by the observatory, and the nearby bomb disposal units were asked to suspend operations during the period of the experiment. With these precautions, the seismic waves were received against a beautifully quiet background, but a few minutes later blasting operations in a forgotten quarry produced an impressive series of anomalous sound-waves.

Times for the first arrivals indicate a slightly higher velocity than that given by the Burton-on-Trent explosion[1], but part of the discrepancy may be due to the delay introduced by the thick alluvial and glacial deposits which underlie the near stations. *Pg* agrees closely with the tables, and two intermediate layers are fairly clearly shown. Transverse waves have not yet been identified at the near stations, but it is not clear whether this is due to the weakness of the pulses or to the characteristics of the field instruments. When the American records are received, it is hoped that they will help towards the solution of this problem.

The operation received support from so many quarters that it is impossible to extend adequate acknowledgments to all those who took part. Many authorities with no immediate interest in the experiment offered the most valuable assistance, and it is to these, no less than to the main participants in the experiment, that the writer wishes to extend the most hearty thanks.

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TRAVELLING-WAVE LINEAR ACCELERATOR FOR ELECTRONS

By D. W. FRY, R. B. R.-S.-HARVIE, L. B. MULLETT and W. WALKINSHAW

Telecommunications Research Establishment, Great Malvern, Worcs.

THE linear accelerator principle as used in the Sloan and Lawrence positive ion accelerator[1] has received a new stimulus from the advent of radar magnetrons giving high peak powers under pulse operation at short wave-lengths. These new techniques are particularly suitable for the acceleration of electrons, since their velocity may easily be made comparable, even at injection, with the velocity of propagation of electromagnetic waves. It therefore becomes practicable to accelerate electrons continuously by carrying them in tight bunches around a stable position in a travelling radio-frequency wave.

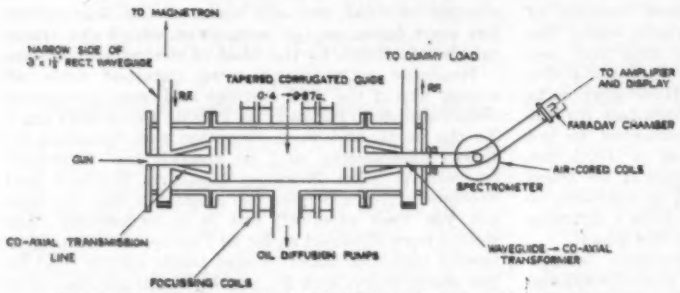

Fig. 1. SCHEMATIC DIAGRAM OF 0·5 MeV. LINEAR ELECTRON ACCELERATOR

The accelerator here described (Fig. 1) employs such a system at a wave-length of 10·0 cm. A travelling wave is set up in a circular wave-guide 40 cm. long carrying an E_{01} mode (that is, having an axial electric field), and the phase velocity of this wave is adjusted by varying the depth of deep corrugations[2] in the wall of the guide so as to keep in step with the velocity of the stable electron (that is, the centre of a bunch) as it is accelerated. In this case the phase velocity at injection is 0·4 c. (45 keV.) and at exit 0·875 c. (538 keV.). The diameter of the open hole along the axis of the guide is adjusted so that under these conditions the accelerating field on the axis is constant. When the peak radio-frequency power is 1 megawatt, this stable position has been designed to be 45° in front of the peak accelerating field. This position of axial stability is unavoidably one of radial defocusing, entailing the use of an externally generated paraxial magnetic field to confine the electrons to tight spirals. Under these conditions rapid bunching occurs, and some 70–80 per cent of the total number of electrons injected should be caught up and accelerated.

An accurate theoretical analysis of these corrugated guides, coupled with extensive experimental work on guides with uniform phase velocity, has enabled the accelerator guide to be produced with the precise law of phase velocity required. The attenuation, as measured in a copper guide of this type having phase velocity c and with ten corrugations per wave-length, is 0·8–0·9 db./metre, which is roughly twice the theoretical value. The corrugated guide is fed by a coaxial line of very low impedance, through an annular space in the end corrugation. The electrons pass through the centre of this coaxial line.

The whole equipment, including the corrugated guide, gun, spectrum analyser, radio-frequency input wave-guide up to the magnetron, and output wave-guide with a steel absorbent load[3], is evacuated to a pressure of 10 millimicrons.

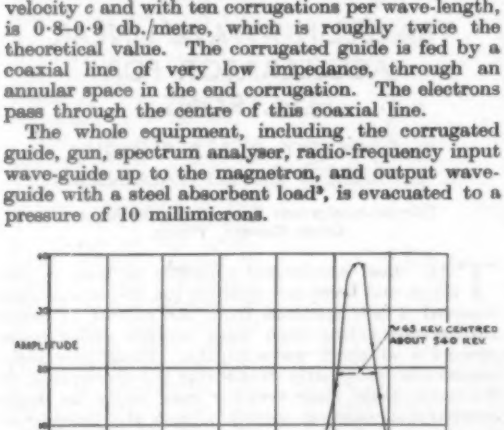

Fig. 2. ENERGY SPECTRUM (RADIO-FREQUENCY POWER, 1MW.)

Experimental Results

The accelerator first worked during November–December 1946, there being no doubt from the moment the radio-frequency power was first applied that it was delivering electrons with the correct order of energy (from simple X-ray measurements). During December a simple magnetic analyser was attached which was calibrated with electrons from the injection gun. Curves such as that shown in Fig. 2 were then obtained for the energy spectrum. The maximum amplitude occurred at an energy very close to 540 keV. (the designed figure), and the width between half-amplitude points was 65 keV. when the applied radio-frequency power was 1 MW.

The total current passing through the accelerator was measured with a Faraday chamber attached to the output end of the accelerator, and typical figures obtained were :

Total cathode emission of gun with R.F. on or off . .	3	μamp. mean
Total beam current into Faraday chamber R.F. off	2·1	μamp. mean
Total " " " " " R.F. on	1·8	μamp. mean

This effectively demonstrated that a very large proportion of the injected electrons, which are, of course, initially spread uniformly along the radio-frequency wave, became trapped by the wave and brought into stable bunches. The effective duty cycle of operation during these experiments was 1/20,000, and the peak beam current during the pulse of ½ MeV. electrons was therefore 36 milliamperes. At times the gun emission has been considerably greater than this without any signs of limitation in output current. The ultimate limitation on the beam current would be the amount of power which could be abstracted from the radio-frequency wave without making a re-design of the corrugated guide necessary to allow for the loading.

Theory indicates that for this particular system there is no stable position for the electrons when the peak radio-frequency power is less than 0·5 MW., and this is confirmed experimentally by the output current falling to zero at this figure. As the power is increased from 0·5 MW. up to 0·8 MW., the maximum current amplitude in the spectrum rises rapidly, then remains virtually constant up to 1·5 MW. The energy corresponding to this maximum current is remarkably constant over the power range 0·5–1·5 MW. The major variation as predicted and observed is in the spectrum width. As the radio-frequency power is reduced, the stable position moves closer to the point of maximum accelerating field and zero defocusing field ; hence less electrons are collected in the bunches, the spectrum narrows, and less external focusing is required. The half-amplitude width of the spectrum in terms of that at 1 MW. is of the order of ½ at 0·6 MW. and 2 at 1·5 MW.

The behaviour of the accelerator to changes of gun voltage is also of interest. If the gun voltage is lowered, we expect the number of electrons trapped in the bunches to decrease, since stable bunches can only be formed from electrons which enter the wave closer to the time of maximum accelerating field. We observed a marked threshold in output current for gun voltages between 20 and 25 kV. Above this threshold the maximum current amplitude of the spectrum rose rapidly at first, then tended towards a

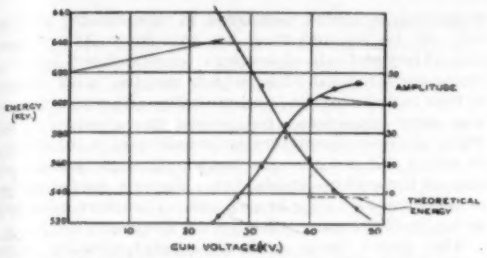

Fig. 3. VARIATION OF AMPLITUDE AND ENERGY OF MAXIMUM IN SPECTRUM WITH GUN VOLTAGE. RADIO-FREQUENCY POWER, 1MW.

limit in the region of 40 kV. upwards. Less external focusing was required at lower gun voltages, giving further confirmation of the change of position of the stable bunch. For a long (efficient) accelerator we would expect the resultant energy of the electrons to be substantially independent of the gun voltage, but for this short case we observed a considerable increase in energy corresponding to the maximum amplitude of the spectrum as the gun voltage was lowered as shown in Fig. 3. This indicated that the time taken by the electrons under these conditions to move to the stable position was long enough for the bunches to travel the full 40 cm. of the accelerator at a consistently higher field than that at the true stable position. For example, at a gun voltage of 25 kV. the energy rose to almost 660 keV., which is approaching the maximum of 700 keV. which an electron could acquire if it rode at the peak of the accelerating field for the full 40 cm.

It is apparent from these measurements that the principle of accelerating electrons in a radio-frequency travelling wave has been proved entirely practical in the region of 0·4–0·875 c. where bunching is occurring.

This 40-cm. length of accelerator was designed to be the first section of one which would be working most efficiently when extended to a length of some 20 metres. Hence only a small percentage of the radio-frequency power is used, the rest being dissipated in a steel load.

In an efficient accelerator the length is chosen so that about 80 per cent of the radio-frequency power is dissipated in the corrugated guide. It is not economical to increase the length of an accelerator to dissipate more than this, for two reasons. In the first place, the decrease in axial field strength due to attenuation reduces the efficiency; and secondly, the frequency stability required from the magnetron if the wave is to be kept in step with the electrons increases in direct proportion to the length. In practice, the second of these is the more severe limitation.

Acknowledgment is made to the assistance given to this project by our colleagues, especially Messrs. R. E. Clay, B. G. Loach, W. A. Gregory, G. T. Hawkins and R. Wharmby. This work was carried out by the Electronics Group of the Atomic Energy Research Establishment at the Telecommunications Research Establishment, Malvern, and acknowledgment is made to Dr. J. D. Cockcroft for permission to publish these results.

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DOMINANCE AND RECESSIVENESS IN THE HUMAN BLOOD GROUPS

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Introduction

BLOOD group antigens show their presence in two main ways. They give rise to agglutination when the red cells containing them are exposed to the action of the corresponding antibody. The antigens may also act as immunizing agents stimulating the production of antibody when they are injected into a person or animal that does not possess the antigen. The property of agglutination is the one almost invariably used in testing for the presence of a blood group antigen.

The possession of a given antigen is usually a clearly defined genetic character; the presence of an antigen is in general dominant to the absence of the same antigen. Sometimes the dominance appears absolute, so that no difference can be detected between the homozygote and the heterozygote.

In many cases, however, especially where two or more antigens are controlled by allelic genes, there is a detectable difference between the homozygote and the heterozygote. There is also some evidence of difference in immunizing power between homozygotes and heterozygotes. Where a quantitative test can be applied and an antigen, though more effective, is not more than twice as effective in the homozygote as in the heterozygote, it may be held that the production of antigen is approximately proportional to the number of the relevant genes present in the tissues, this being twice as great in the homozygote as in the heterozygote. Where, however, the antigen in the homozygote is more than twice as active as in the heterozygote, it is clear that the alternative or allelic gene in the latter is producing an active inhibitory effect and is itself giving rise to a partially dominant character, even though it may not be producing any detectable antigen. In this paper an attempt is made to review the evidence for dominance and recessiveness in each of the principal blood group systems.

Landsteiner Blood Groups

For the *ABO* system Bernstein's[1] formulation of the genetics, with three allelic genes giving rise to the properties *A*, *B* and *O*, accounts for the observed facts with a high degree of accuracy. The position is, however, complicated by the existence of hereditary subgroups of *A* (A_1, A_2, etc.), and probably of *B* as well. The sera commonly used for testing for the *ABO* groups are anti-*A* reacting with A_1 and A_2, anti-A_1 reacting only with A_1, and anti-*B* reacting with *B*. In terms of the reactions with these three sera, A_1 is slightly dominant to *B* and *B* is slightly dominant to A_2. A_1 is absolutely dominant to A_2; and A_1, A_2 and *B* absolutely dominant to *O*, since *O* cells react with none of the sera.

There exists, however, an anti-*O* antibody (or possibly more than one) which reacts strongly with *O* cells, very weakly or not at all with A_1B cells, and intermediately with other groups.

It is tempting to suppose, with Thomsen[2], that this antibody reacts with an *O* antigen due to the presence of Bernstein's *O* gene; but the abundant published work on the subject shows that the position is far

less simple than this, and no genetical theory has yet been put forward which covers all the published observations. It is impossible to discuss here the relative merits of the theories of Matta[3], Hirszfeld[4,5], and Moureau[6]. Rather must we await yet more experimental work. The very extensive work of Hirszfeld and the unusual genetical conclusions to which it leads him, however, demand consideration. This author, by titrating *A* cells with anti-*A* and anti-*O* sera, claims to have subdivided group A_1 into 'pleiades' A_j, A_r and A_m such that in terms of dominance $A_j > A_r > A_m > A_2 > O$. This dominance, he claims to show, is not only true for the reactions with anti-*A* but also for those with anti-*O*. The relations in respect of reactions with anti-*A* are only an extension of the well-established relations of A_1, A_2 and *O*, but the implications with respect to anti-*O* are more remarkable. It is claimed, for example, that the genotypes A_jA_j, A_jA_r, A_jA_m, A_jA_2 and A_jO constitute a single phenotype, reacting equally not only with anti-*A* but also with anti-*O*. Thus the gene A_j, which confers the property of reacting only feebly with anti-*O*, suppresses completely the effect of any gene tending to confer stronger reactions with anti-*O*, even that of the *O* gene itself.

If we accept Hirszfeld's observations we can scarcely avoid his conclusions, which may be summarized by saying that the *O* antigen recognized by the antibody anti-*O* bears no direct relation to the *O* gene of Bernstein, but is in the nature of a species agglutinogen which occupies a remainder of certain receptor sites on the red cell after the *A* and *B* agglutinogens have, according to their strength, occupied their territory. Hirszfeld, in fact, regards A_2, A_m, A_r, etc., as successive mutations of *O*, so that each *A* gene causes a progressively greater replacement of *O* substance on the cell by *A* (or of alteration of *O* into *A*). In connexion with Hirszfeld's work, it must be borne in mind that, while most anti-*O* sera are of animal origin, very rare examples of an apparently identical antibody are found in the sera of A_1B and even of A_1 persons.

M, *N* and *P*

The relations between *M* and *N* are, on the whole, similar to those between *A* and *B*. There are two allelic genes, *M* and *N*, and two antibodies, anti-*M* and anti-*N*. The reactions of either antigen are weaker in heterozygotes than in homozygotes. The weakening effect of *N* upon *M* is the greater, hence *N* may be regarded as partially dominant. There exists a rare weakly reacting form of *N* known as N_2, which is concealed by *N* as A_2 is by A_1. (In addition, *M* is partially dominant to N_2.)

In the *P* system cells show two fairly well-defined strengths of positive reaction; but whether the strong reactions are those of homozygotes or of 'stronger' genes, or are due to some modifying factor, is not known. Quantitative tests with anti-*P* sera on a large number of families are much to be desired.

Rh System of Groups

The *Rh* system, though it is the most complex of the blood group systems, is characterized by a body of serological observations and of genetical theory which, in spite of controversy on nomenclature, is accepted in its essentials by nearly all workers.

Rh positiveness was first defined[7] in terms of a character which caused agglutination of the red cells in question with an antibody 'anti-*Rh*'. This character was inherited as a mendelian dominant to *Rh* negativeness which consisted in the failure of the cells to be agglutinated by anti-*Rh*. Afterwards two other red-cell characters were defined by the discovery of antibodies which reacted with them, at first called anti-Rh_1 and anti-Rh_2. *Rh* negativeness was now considered to involve the absence of all three of these characters or homozygosity for a gene *rh* which did not give rise to red cell agglutination by any of these three antibodies. Various combinations of reactiveness to the known antibodies were inherited as single characters, but all were dominant to *rh*.

The above facts and their interpretation were worked out almost simultaneously by Wiener[8] in the United States and by Race and Taylor[9] in Britain. The latter workers had, however[10], also discovered a fourth antibody which reacts with all *Rh*-negative cells and with some *Rh*-positives, including all, whether homozygous or heterozygous, containing the gene *rh*, which in this sense behaves as a dominant. An empirical nomenclature devised at this point might well have assigned an equal degree of dominance to all the antigens; but the nomenclature which had been evolved stage by stage by Wiener was adopted by Race and Taylor, and this tacitly assigned recessiveness to the character defined by *St*.

At this stage, Fisher[11] propounded his theory of the *Rh* complex, according to which three closely adjacent chromosome loci are involved, which can be occupied respectively by three dominant genes *C*, *D*, *E*, or recessives *c*, *d*, *e*. Of the previously recognized 'genes', Rh_2 is *CDE*, *rh* is *cde*, and all the others are combinations of dominants and recessives such as Rh_1, which is *CDe*. To each of the six genes corresponds an antigen reacting with one and only one antibody. The essence of the theory lies in the postulation of three pairs of allelomorphic antigens rather than in the precise chromosomic arrangements involved.

Anti-Rh_1 (in the original sense) reacts with *C*, anti-*Rh* with *D*, anti-Rh_2 with *E*, and *St* with the recessive *c*. Fisher predicted the discovery of antibodies to the antigens mediated by the genes *d* and *e*. Anti-*e*[12] has now certainly, and anti-*d*[13] almost certainly, been identified.

Race and Taylor found that the reactions of the dominant antigens were only just perceptibly greater in a subject who was homozygous than in one who was heterozygous for the corresponding genes. The *St* antibody, on the other hand, showed a titre approximately eight times higher with a double dose than with a single dose of the appropriate antigen. A similar effect was found[12] with *Br* and with the rare allele[14] of *C* and *c* called C^w. Thus while the effects of the dominant genes are at most proportional to the number of them present in the nucleus, it is clear that the full maximum effect of the recessive genes is only manifested in homozygotes and is actively inhibited by the presence of the corresponding dominant genes. Thus, in respect of antigen-antibody reactions the genes *C* and *E* do show a partial dominance over *c* and *e* respectively.

Again, with regard to immunizing power, *C* is a powerful antigen, and when present only in a single dose, as in most erythroblastotic babies of *c* mothers, it frequently provokes antibody production. On the other hand, *c*, though present in a comparable number of cases where the mother lacks the antigen, only very rarely provokes antibody production. Moreover, of the small number of published cases of immunization by *c*, two are cases of transfusion reaction[14,15], where blood of genotype *rh rh* with a double dose of *c*

had been given to a *CC* individual. Considering the rarity of transfusion as compared with pregnancy in the general population, this suggests that *c* not inhibited by *C* is probably a more powerful immunizing antigen than it is when so inhibited.

In the case of *E*, maternal immunization with a single dose is rarer than with *C*, but many cases are known. On the other hand, no case has hitherto been described of maternal immunization by *e*. Here the presence of a single dose of antigen in the babies of mothers lacking it is rarer than for *E*, but not incomparably so (about 1/7 as common). The only case yet described of immunization by *e* is that of an *EE* male who had been transfused with blood from about forty different donors, of whom nearly thirty would be expected to be homozygous for *e*. Here again, therefore, it appears that *e*, when homozygous, is a much better antigen than when heterozygous.

D is undoubtedly the best immunizer of all the *Rh* antigens, acting very well on mothers when single doses are present in their babies. Though single doses of *d* are very common in babies, only one case has ever been mentioned where it is claimed[13] that a mother has been immunized by *d*.

The evidence in the case of *c* and *e* shows that these are antigens comparable in strength of antigen-antibody reactions and probably in immunizing power with *C*, *D* and *E* when, and only when, they are not inhibited by *C* and *E*, the partial dominance of which is thus demonstrated.

The position with regard to *D* is not so clear. The strength of its reactions with anti-*D* is clearly not inhibited by the presence of *d* in the genotype, and thus *D* is to be regarded as a dominant. The antigenic status of *d* has only recently been announced. It is clearly a very weak antigen, and indeed until this announcement the *d* gene was regarded as resembling the recessive *O* gene in that neither had been proved to give rise to an antigen.

In general, nearly every blood group gene has been found to give rise to a corresponding antigen, and this is always detectable whether present in double or single dose in the genotype. Within each blood group system a linear series of antigenic characters can be established, of which each member shows a slight degree of dominance to the next. The evidence is, however, of a very patchy nature, and the subject is one which deserves, and is indeed receiving, much further investigation.

I wish to thank Dr. M. Bessis, Profs. D. F. Cappell, R. A. Fisher and A. Franceschetti, and Drs. W. T. J. Morgan and R. R. Race for advice, criticism and stimulating and suggestive discussion during the preparation of this paper.

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OBITUARIES

Prof. W. W. Watts, F.R.S.

By the death on July 30 of Prof. William Whitehead Watts, the doyen of British geology, we have lost a great exponent of the science and an able administrator.

Born on June 7, 1860, at Broseley, in Shropshire, he received his early education at Denstone College, where he distinguished himself in classics. But his youthful interests had already turned to geology, since the opportunities for the collection of fossils from the famous localities near his home and the study of a great variety of rock-formations and scenic types were unusually attractive, and he made full use of them. He entered Sidney Sussex College, Cambridge, in 1878, and later was elected to a fellowship. It is worthy of note that he took the Tripos papers in geology (and not those in chemistry, as he had intended, because on the examination day they looked more healthy), being placed in the first class of the Natural Science Tripos. We cannot assess the loss to chemical science, but the gain to geology is obvious.

Soon after Watts left Cambridge, he was occupied as a University extension lecturer in geology. By deputising for the professors of geology at Leeds, Birmingham and Oxford, he gained valuable experience in dealing with men individually and collectively. From 1891, for a period of six years, he acted as petrographer to the Geological Survey of Great Britain, spending much time in Ireland, where he produced the "Guide to the Collection of Rocks . . . belonging to the Geological Survey of Ireland", which has been a valuable work of reference to this day.

Then followed his appointment as assistant professor of geology at Birmingham, a post held in part conjointly with the professorship of geography. There, with the impress of Chas. Lapworth's genius strong upon him, he re-investigated and described the geology of parts of his native county, including the Shelve District, the Breidden Hills and the Long Mountain. He also published geological accounts of the country around Birmingham and the neighbouring Forest of Charnwood, where the landscape of pre-Cambrian rocks, buried under Triassic deserts, was so graphically described by him that it will be for ever associated with his name. His elegant interpretation of the stratigraphy, volcanic phenomena and tectonic history of this unique development of pre-Cambrian rocks made his work a model for students. In recent years, he returned to and amplified these early studies, and had the satisfaction of seeing shortly before his death the page-proofs of his book on Charnwood.

During the Birmingham epoch, also, Watts produced his famous little manual, "Geology for Beginners" (Macmillan and Co., Ltd.), which brought him, as he rejoiced in saying, a host of friends: certainly, it inspired many students to take up a geological career.

It was thus as an experienced teacher and an original investigator of considerable repute that he was invited to succeed J. W. Judd in 1906 as professor of geology in the Royal College of Science and Royal School of Mines, London, at that time in course of being incorporated with the City and Guilds Engineering College to form the Imperial College of Science and Technology. His outstanding success as an organiser had already become manifest

since, among other offices to which he had been called, he had been secretary of the Geological Society (when he organised the centenary celebrations), secretary and recorder of Section C of the British Association and prime mover in originating and running its Geological Photographs Committee.

In London, Watts was soon heavily engaged in administrative duties, both in the geological world and in the University, where he became chairman of the Board of Studies in Geology, dean of the Faculty of Science and senator. He planned the lay-out and equipment of a new department at the College and extended its activities by establishing a Sub-Department of Oil Technology shortly after his arrival, and after the First World War a Sub-Department of Mining Geology. With commendable foresight he insisted on the retention of the school of the fundamental science as a department of the Royal College of Science, while the other two departments—applied science—appropriately found a home in the Royal School of Mines. Believing strongly in "Geology in the Service of Man" (the subject of one of his presidential addresses) he arranged for students of the City and Guilds College to attend a full course of lectures, laboratory work and field-surveying in geology for civil engineers, the first of its kind in Great Britain. Under his inspiration, research students steadily increased in numbers, coming from other universities in Britain, the Dominions and foreign countries.

Watts was wont to say that early in his London days he realized that he had to choose between being a teacher or a researcher. He never regretted his choice as time passed and he saw his old students occupying responsible posts, a score as professors, many as directors of geological surveys in various parts of the world, and even more as leading technologists in the business world, in oil, mining and other undertakings.

Among the public offices Watts filled were the presidential chair of Section C of the British Association (twice), the Geologists' Association (twice), the Geological Society, the Mineralogical Society and the British Association (Norwich, 1935). During 1917–23 he was secretary of the Conjoint Board of Scientific Societies—at the time when the world-embracing Catalogue of Scientific Periodicals was compiled.

Many other honours came to him. He was made an honorary fellow of Sidney Sussex College and of the Imperial College, hon. LL.D. of the Universities of St. Andrews and Edinburgh, fellow of the Royal Society (1904), Murchison Medallist (1915) and Wollaston Medallist (1927) of the Geological Society. He was an emeritus professor of the Imperial College and the University of London, an honorary fellow of the Royal Society of Edinburgh, a fellow of the Royal Society of Canada and an honorary member of many other learned societies.

Among the subjects he dealt with, in his characteristically vivid and witty style, were informative reviews of palæogeography in the light of present-day crustal features, the potentialities of British coalfields, other economic aspects of the science, the history of geology and continental drift.

Such, in brief, is the record of a remarkable career. No man exercised more beneficent influence on the progress of British geology in his day, doubtless in no small measure by reason of his dominating personality, manifest humanity and great personal charm. Small wonder is it that his students felt an immense affection for him.

P. G. H. Boswell

Mr. H. A. Hancock

Coming straight from a Manchester school in 1916 to the newly formed Experimental Department of the Fine Spinners' and Doublers' Association, Ltd., Hancock presently became the writer's personal assistant. He had useful hands, and a remarkable freedom from subjective error; long dull series of observations were in no way biased, and yet—the data at last obtained—he switched over to keenness in extracting every significant fact from them. In later years he similarly used statistical technique with exceptional discrimination. He became joint author of papers in cotton cell-wall structure, contributing several essential points. Although primarily a physicist, he acquired botanical interests which were of value later when he worked in closest liaison with cotton growers in a mill standing on a farm.

He was Lancashire, with a business sense, and also a diplomatist, so that he was the usual envoy to any distrustful mill manager. This diplomacy had full scope during his service in Egypt; but, like statistical technique or his skilled photography, it was only a tool for use in helping to do the job.

In the use of words his method was like a drawing by Phil May; nothing unessential was left in. Two pages of foolscap held his report on six weeks mission in the United States; nothing was omitted in its definite and important conclusions. It was his last writing before his death on July 23 at the age of forty-four.

In 1927 he moved to the Shirley Institute, Manchester, where he worked on the testing side, widening his experience of the cotton industry, taking a first-class honours B.Sc. in physics and making a happy marriage with one of our former colleagues. Meanwhile, in Egypt it had been made practicable to start on the project of a spinning test mill. Hancock was not an obvious chief for it; he had never been a spinner, but the job was evidently going to be beyond all boundaries of precedent. So he arrived in 1934, finding only a climate-insulated building under construction for him to equip and staff. Scrupulously fair dealing served as a charm whereby skilled operatives were made out of raw material, and his infinite capacity for taking pains made the "S.T.M." incredibly efficient.

Results began to arrive fast and faster. Egypt had been promised a hundred and fifty tests a year, though privately we expected a thousand; after twelve years Hancock was producing a hundred and twenty a day with improved accuracy as routine, for weeks on end. Having shown mixtures to give an exact weighted-mean result he sampled all Egypt every year, with the collaboration of Alexandria's exporters, and thereby proved that smooth curves connected world-price and relative yarn-strengths. So the spinning-test became a direct valuation; after that we knew the market value of newly bred varieties years ahead of their public appearance. Matters of trade argument were swept up in the meshes of ordinary routine, a thousand spinnings or so at a time. Prediction of the all-important yarn-strength from the hair-properties was not quite complete, but the correlation coefficient reached 0·95. He located the effects of 'grade' and analysed most of its causes. The detailed incidence of natural crossing in the field was measured by spinning.

Such things as these were all useful, but he struck a vein of fundamental research by applying his technique to statistical genetics. Our unobtrusive

handling of the crop by a seed-renewal system of pure lines, under spinning control, was adding to Egypt's wealth by more than fifteen million pounds yearly, but cracks were visible to us at Giza. Two pure-line varieties showed deterioration impending, which pure lines should not do. We knew our definition of 'purity' to be pragmatic, and no visible characters were at fault; nevertheless those yarns were getting weaker. Hancock used everything he possessed of physical and mental equipment in a complete demonstration and abolition of the trouble, laying down a simple 'nucleus-seed' control system which—if the Egyptians continue to use it—has eliminated its recurrence. He first applied the spinning-test to all seed-lots of the high-quality cottons, arresting further decay; then he excavated through cubic metres of the plant-breeders' files from 1924 onward, until he could present the exact pedigree of every family; this showed that an occasional use of open-fertilized seed (against all orders) had introduced the unwanted genes. The strength of yarn was shown to integrate the effect of hundreds of genes, and the only available indicator of genic change was yarn-strength—which is the spinners' only requirement.

Hancock's last printed publication, towards the end of the War, was a trilogy of papers on the practical aspects of this theme. He had to re-write them completely, because the publishers disliked the style he had chosen to catch the spinners' interest. This, after five Egyptian war-time summers, was tiresome, for besides his proper work he had been helpful in many details of the war in the Middle East, and had directed a systematic examination of captured enemy textiles. A possibility of leave in 1945 had to be forgone, and by the winter he was involved in organising 'cotton missions' abroad, out of an exaggerated sense of loyalty to his Minister, himself taking the United States mission.

Meanwhile, he was offered the Bombay Technological Laboratory post, at threefold his pay in Egypt, and arranged to leave Giza after his American trip. Before he returned to Giza (his plane having been struck by lightning on the way) the Indian appointment had failed of confirmation, for political reasons, and he had to re-cast his plans. India's offer was renewed later, but by then he was on sick-leave in England, with confidence lost, no longer able to cope with conditions. His keen interest in world affairs increased the depression induced by the frustrations of Egypt and India, so that the end was such tragedy as Hardy wrote.

W. Lawrence Balls

NEWS and VIEWS

Agricultural Research Council : A New Institute of Animal Physiology

The Agricultural Research Council, with the support of the Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland, has decided that in many directions progress towards the improvement of animal health and production is restricted by lack of knowledge of the fundamental physiology, normal and abnormal, of farm animals, and that to fill in some of the gaps in our knowledge a new Institute of Animal Physiology is needed. It has been decided that the Council should establish such an Institute, since the work which must be done needs the provision of buildings, land and large animals on a scale which would not be appropriate to a university department. Prof. I. de Burgh Daly, professor of physiology in the University of Edinburgh, has been appointed director, and will take office early in 1948. It is intended to appoint as Prof. Daly's senior colleagues a biochemist and a pathologist, so that the full range of problems bearing on the physiology of farm animals may be studied, including practical problems arising in the course of the handling and care of animals on the farm. A site for the new Institute has not yet been chosen, but preference will be given to one sufficiently near to a university to facilitate close contact between scientific workers in the Institute and those in University departments.

Prof. I. de Burgh Daly, F.R.S.

Prof. Daly has held the chair of physiology in the University of Edinburgh since 1933. He was educated at Rossall School, at the University of Cambridge, where he took first-class honours in Part I of the Natural Science Tripos and was Thurston Medallist of Caius College, and at St. Bartholomew's Hospital. In the First World War Prof. Daly was a fighter pilot in the Royal Naval Air Service. He was a member of the staff of the Department of Physiology, University College, London, during 1919–23, a Beit Memorial Fellow, and lecturer in experimental physiology in the University of Wales, Cardiff, in 1923, before being appointed professor of physiology in the University of Birmingham in 1927, where he worked until he was appointed to Edinburgh in 1933. During the Second World War, Prof. Daly carried out research on the physiology of high-altitude flying and on poison gases in Edinburgh during 1939–43. From 1943 until 1945 he was director of the Physiological Laboratory of the Medical Research Council at Lulworth, which was responsible for the investigation of the physiological factors determining the fighting efficiency of the crews in armoured fighting vehicles.

Agriculture at the University of Reading

The autumn term at the University of Reading will witness two important changes in the professorial staff of the Faculty of Agriculture. The first is that Prof. H. A. D. Neville, who has occupied the chair of agricultural chemistry since 1919, and has been dean of the Faculty for almost as long a time, retires at the end of September. He is succeeded, as regards the chair, by Dr. Cyril Tyler, who has been lecturer in agricultural chemistry in the University. Prof. H. G. Sanders, professor of agriculture, will take over the duties of Dean of the Faculty.

Prof. Neville went to Reading with a training —undergraduate and post-graduate—under the late Prof. T. B. Wood in Cambridge and after service with the Forces in the First World War. At that time the University of Reading had not received its charter, the Faculty of Agriculture was scarcely on its feet, and the study of agricultural chemistry had barely begun. Prof. Neville's knowledge, administrative wisdom and drive as dean of the Faculty have been largely responsible for the unfaltering progress and development of the study of agriculture and its associated sciences, first in the University College and

later in the University, which have led to the outstanding position in agricultural science now held by Reading. His able and tireless work as dean was no small contribution to the sum of achievements which, under the leadership of Dr. W. M. Childs, made possible the granting of the charter to the University in 1926. The orbit of Prof. Neville's influence on agricultural education and the advancement of agricultural science has extended beyond Great Britain. Former students of his are to be found in many of the faculties of agriculture, and in most agricultural departments of state, in the British Commonwealth. It is fortunate that even after his retirement, his long experience and wise counsel are still to remain available for wider service to university progress and development in Britain. Prof. Neville's successor in the chair of agricultural chemistry, Dr. C. Tyler, is, at the age of thirty-six, already well known for his researches on poultry nutrition and metabolism. A graduate of Leeds, he was lecturer and head of the department of agricultural chemistry at the Royal Agricultural College, Cirencester, before he went to Reading in 1939.

The other change in the Reading faculty is the appointment of Mr. E. L. Crossley to the chair of dairying. The former occupant of this chair, Mr. E. Capstick, resigned in 1946 on his appointment to an important post in the dairy industry. Mr. Capstick, who was the first university professor of dairying in Great Britain, took to Reading an almost unique combination of academic knowledge of the science underlying the dairy industry and intimate experience of modern methods of large-scale manufacture, but he had scarcely taken charge of his department when war broke out. He was shortly afterwards seconded, at the request of the Ministry of Food, for service with that Ministry in connexion with the control of dairy products. He continued with the Ministry until 1946. His successor, Mr. Crossley, has for some years been recognized as one of the ablest of industrial bacteriologists. Since 1929 he has been technical adviser to the well-known dairy manufacturing firm of Aplin and Barrett, Ltd.

Department of Scientific and Industrial Research : Scottish Office

THE Department of Scientific and Industrial Research has opened a Scottish Office at 18 Melville Street, Edinburgh, to facilitate closer contact with Scotland. The office will have a dual function—to encourage the prosecution of research by industry itself and to increase the effectiveness of the contribution which existing Government research establishments make to Scottish industry. The new office will co-operate with the Departments of the Secretary of State for Scotland, with the organisations in Scotland of other Government departments, and with voluntary bodies such as the Scottish Council (Development and Industry). It will also study the Scottish industrial position with the view of assisting in the formulation of problems suitable for research. The office will apply existing research facilities as effectively as possible to Scottish needs. Dr. H. Buckley will be in charge of the new office. A graduate of the University of Manchester, Dr. Buckley was for a time on the staff of the University of Toronto. He returned to Britain and entered the National Physical Laboratory, where he served for twenty-five years, his special field of research being photometry and illumination. During the Second World War he was for a time a liaison officer in the British Commonwealth Scientific Office in Washington and, during the last three years, he has been a member of the Intelligence Division at the headquarters office of the Department of Scientific and Industrial Research.

Atomic Energy Train Exhibition

THE Atomic Scientists' Association, with full co-operation of the Ministry of Supply, is organising a travelling train Exhibition on Atomic Energy which will start at the beginning of November, touring twenty-six towns in England, Scotland and Wales. The aim of the exhibition will be to give the public the basic facts of atomic energy and explain its implications; its destructive and constructive purposes. The exhibition will be fitted in two coaches. The first half of the exhibition will deal with the basic principles of atomic energy. These will be illustrated by means of charts, photographs and working models. But in addition to these there will be several experiments showing the instruments used in laboratories for the detection of radioactivity, and the process of splitting uranium atoms. There will also be an experiment showing the production of artificial radioactivity. In the second part, the application of atomic energy will be shown with models illustrating the chain reaction in uranium, the principles of separation of isotopes and atomic energy piles. The applications of atomic energy to medicine and biological sciences will also be illustrated. The instruments used in the tracer technique in medicine will be shown. Scientific men will be in attendance to give additional explanations. It is planned to organise at the same time Atomic Energy Weeks in each town visited, when lectures and film shows will take place. There will be, in collaboration with various local organisations, public meetings, 'brains trusts' and conducted parties for schools, etc. The choice of towns to be visited was dictated largely by train requirements and existing facilities at the various stations. These facts have eliminated a number of towns which were intended to be fitted into the itinerary. The official opening will take place at Liverpool, but the first showing to the public will be at Chester on November 10. Inquiries should be addressed to the Press Office, Ministry of Supply, Shell-Mex House, Strand, London, W.C.2.

Jubilee of the Discovery of the Electron

THE Institute of Physics and the Physical Society, in collaboration with the Institution of Electrical Engineers, will celebrate, on September 25 and 26, the jubilee of the discovery of the electron by J. J. Thomson. Special lectures and meetings are also being arranged at various centres in the Dominions. In London, a lecture addressed to the non-scientific public by Sir Clifford Paterson will be given at the Central Hall, Westminster, at 7.30 p.m. on September 25 entitled "The Electron Liberated". The lecture will be illustrated by experiments and demonstrations. Admission is by ticket only, which may be obtained free of charge from the Institute of Physics, 47 Belgrave Square, S.W.1; requests should be accompanied by an addressed envelope. Industrial organisations and universities have collaborated with the authorities at the Science Museum, South Kensington, in arranging a special exhibition, to be opened on September 26, which will remain open for about three months. The exhibition is designed to show the principles underlying the applications of the many

devices in which the electron plays an essential part, and to show the important part these developments play in modern daily life. The exhibits will range from Thomson's original apparatus to the most modern developments, such as the electron microscope. A handbook has been specially written by Mr. D. H. Follett, of the Science Museum (at the Museum, or from the Institute of Physics, 1*s.* 2*d.* post paid); the first part is a guide to the exhibition and the second is a general account of the subjects dealt with in the various sections of the exhibition.

Hydrocyanic Acid and Poliomyelitis

POLIOMYELITIS (infantile paralysis) in human beings is ordinarily regarded as an infectious disease caused by a virus. While it is true that a virus has been isolated and can be transmitted to monkeys, there are many features in the incidence of the disease which are difficult to reconcile with the virus hypothesis. The epidemiological features of the disease strongly suggest that food is concerned in its spread, but repeated attempts to demonstrate an infective agent in the food have failed. The occurrence of local outbreaks under certain seasonal and climatic conditions and the apparent absence of direct case-to-case transmission are suggestive of some form of food poisoning. R. R. Scobey (*Archiv. Pediatrics*, New York, **63**, 322; 1946) puts forward the theory that the disease is primarily due to hydrocyanic acid poisoning; either the hydrocyanic acid directly poisons the nerve cells, or else it makes them susceptible to a virus which is normally about the body. Hydrocyanic acid, in the free state or in the form of mustard oil or cyanophore glucosides, is now known to be present in many of the vegetables and fruits which are ordinarily consumed during the time of year when poliomyelitis is prevalent. The plants concerned belong to the Cruciferæ (mustard, horse-radish, cauliflower, cabbage) and Rosaceæ (most of the ordinary stone-fruits and berries). The symptoms and pathological changes which occur in experimental hydrocyanic acid poisoning in animals and in many of the recorded cases of poisoning in man bear a striking resemblance to those of poliomyelitis. The hydrocyanic acid content of plants shows a marked seasonal variation. The geographical distribution, seasonal incidence and climatic conditions observed during epidemics of poliomyelitis can be correlated with a high hydrocyanic acid content of the local flora and with the feeding habits of the community. Scobey brings together much circumstantial evidence in support of his theory, which will deserve serious attention, for this is a disastrous disease for which no rational therapy is at present available.

Immigration into Britain of Continental Butterflies

AUGUST 1947 was marked by the large-scale immigration of certain Continental butterflies which are infrequent visitors in the British Isles. Most striking was the extensive arrival of the clouded yellow (*Colias croceus* Fourcrory), which ranged from southern England to Scotland, and included specimens of the pale greenish-white female variety *helice*, and a few of the scarcer pale clouded yellow (*Colias hyales* Linn.). Even more interesting was the appearance in the north of England of the Camberwell beauty (*Nymphalis antiopa*, Linn.) after an absence of many years. At a meeting of the Merseyside Naturalists' Association on August 24, A. J. Cobham reported the appearance of this insect at Maghull, Lancashire, the previous week, and afterwards a specimen was caught at Birkenhead, Cheshire. This insect migrates across the North Sea from its haunts in northern Europe, from Scandinavia to Germany and Holland, whereas the clouded yellow's migration route is from North Africa across France. 1941 was the last notable 'clouded yellow' year, the greatest immigration since 1877, while 1917 was remarkable for Camberwell beauties: the Camberwell beauty was first recorded in Cool Arbour Lane, Camberwell, London, in August 1748. There has also been a marked invasion of death's head hawk moths (*Acherontia atropos* Linn.) in the north of England, and numerous larvæ of these Continental moths were found in potato fields during August.

Stanislaw Kalinowski and the Swider Geophysical Observatory

No. 10 of the *Travaux de l'Observatoire Géophysique a Swider*, Poland, is the first publication of the Observatory for seven years; geophysicists will welcome this reappearance of the journal, more especially in view of the great sufferings of Poland during the War, and the continuing difficulties there. But they will mourn the loss, reported in this issue of the *Travaux*, of the founder and director of the Observatory, Stanislaw Kalinowski, whose death occurred early last year, at the age of seventy. Many who were present at the Edinburgh assembly of the International Union for Geodesy and Geophysics, which he attended with his daughter, will cherish recollections of his ardent interest in the science of geomagnetism, which he served so long and so well, particularly through the founding of the Swider Observatory in 1921, and through the magnetic survey of Poland which he conducted from that base. This issue of the *Travaux*, prepared by his hand, besides giving hourly values of the magnetic elements at Swider for the year 1936, summarizes the results obtained for the daily variation of the magnetic elements over the period 1921–35; it also contains a vivid account of the fortunes of the Observatory during the Second World War. An introduction to the publication, written by another hand, gives a moving account of his own heroic struggles, amidst afflictions that would have crushed many a younger man, to defend his Observatory from Nazi avidity and to maintain its work. He never lost faith in the overthrow of the conquerors of Poland, and made plans for the end of the War and the future of the Observatory. It is good to know that State provision has now been made for the Observatory, and that it has been newly named after its distinguished founder.

A Fully Automatic Low-Temperature Cabinet

J. and E. HALL, LTD., of Dartford, Kent, have recently produced, for research purposes, a fully automatic low-temperature cabinet which can run at a temperature of −95° C. The manufacturers believe this to be the only plant available of this type, developed and manufactured entirely in Great Britain. The unit has been produced almost exclusively from normal standard equipment. Refrigeration is accomplished by the use of two small 'Hallmark' refrigerating compressors of conventional standard design which are arranged to run in cascade, suitable refrigerants being chosen for the high and low stages. The cooled cabinet consists of a cylindrical metal vessel, 19½ in. internal diameter by 36 in. high. The whole equipment is arranged on a chassis which can be easily moved from one labdratory

to another, the only services required being electricity and water. Safety precautions are such that whether the plant is switched off, the current interrupted involuntarily, or the water supply interrupted, it is not possible for dangerously high pressures to develop in any part of the system.

International Conference on Soil Mechanics and Foundation Engineering

THE Second International Conference on Soil Mechanics and Foundation Engineering is to be held in Rotterdam during June 21–30, 1948, on the invitation of the Netherlands Government and the Municipality of Rotterdam. The following subjects have been selected for discussion: (*A*) *Technical and Scientific Topics:* theories, hypotheses, considerations of general character; investigations in the laboratory and in the field; stability and deformation of earth and earth constructions; stability and movements of soil-retaining constructions; stress distributions under foundations and settlements of structures; pile foundations, pile loading tests; problems in highway and runway constructions (superstructure); methods for improving the mechanical quality of soils; groundwater movements. (*B*) *Topics of a General Character:* survey of the existing institutions and individuals working in the sphere of soil mechanics; suggestions for international co-operation. Anyone interested in the Conference, whether from the point of view of practical application, research or teaching, is welcome to attend the meetings and to contribute reports or discussions. The president of the Conference is Prof. K. Terzaghi and the secretary Prof. A. Casagrande. An organising committee has been appointed under the chairmanship of Ir. J. P. van Bruggen, with Ir. T. K. Huizinga as secretary and Ir. W. C. van Mierlo as treasurer. The Institution of Civil Engineers has convened a British National Committee under the chairmanship of Mr. W. K. Wallace, and full particulars of the Conference can be obtained from the Secretary, Institution of Civil Engineers, Great George Street, London, S.W.1.

American Philosophical Society Publications

THE American Philosophical Society has issued reports of two symposia held last year at Philadelphia (*Proc. Amer. Phil. Soc.*, **90**, No. 4; 1946), both of very general and vital interest, one of them on "Present Day Social and Economic Aspects of National Health" and the other on "U.N.E.S.C.O. and American Participation in its Activities". As to the first of these symposia, it is obviously profitable to compare notes with the United States on the health of the people, on the role of Government agencies in a national health programme, and on the place of the physician in modern society. The other symposium is of great value as giving a comprehensive view of the United Nations Educational, Scientific and Cultural Organisation written by well-informed Americans.

Durban Museum and Art Gallery

THE annual report of the Durban Museum and Art Gallery for the year 1945–46 again stresses the need of these expanding institutions for extra space. "The congested conditions," it is stated, "become more acute each year." Though the City Council has allocated several extra rooms in the municipal building for museum purposes, it is pointed out that this will only relieve the position as regards workroom, storage and library accommodation, the urgent need for further exhibition space remaining a matter which requires serious consideration. The total number of visitors to the Museum and the Art Gallery during the year was 166,922 and 154,397 respectively.

Announcements

THE Ernst Julius Cohen Memorial Lecture of the Chemical Society will be given by Prof. F. G. Donnan at the rooms of the Chemical Society, Burlington House, London, W.1, on October 2 at 7.30 p.m.

DR. J. A. B. SMITH, lecturer in applied biochemistry with special reference to nutrition at the University of Glasgow, has been appointed deputy director of the Hannah Dairy Research Institute.

THE Melchett Medal for 1947 of the Institute of Fuel has been awarded to Major Kenneth Gordon, who will deliver his Melchett Lecture on "Hydrogenation in the Fuel and Chemical Industries" at 2.30 p.m. on October 16 at Gas Industry House, 1 Grosvenor Place, London, S.W.1.

THE selection committee of the Harrison Memorial Fund, consisting of the presidents of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society, will make an award of the Harrison Memorial Prize in December 1947. The Prize, not exceeding £150, will be awarded to a chemist of either sex, who is a natural-born British subject and not at the time more than thirty years of age, for original investigations published during the past five years. Communications relating to the award must be received by the President, Chemical Society, Burlington House, Piccadilly, London, W.1, not later than December 1.

THE Meldola Medal is the gift of the Society of Maccabeans and is normally awarded annually. The next award will be made early in 1948 to the chemist who, being a British subject and less than thirty years of age at December 31, 1947, shows the most promise, as indicated by published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before that date. Communications, either by persons who desire to recommend a candidate or by a candidate himself, should be sent to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

THE Library of the joint institutions, the Botanical Garden and Institute, and the Cryptogamical Laboratory, Pavia (founded in 1871, the world's oldest laboratory devoted to the study of plant diseases), a centre for studies on fungicides, for human and comparative mycopathology (botanical section), and for mushroom culture, wishes to exchange biological and general scientific periodicals and reprints with English institutions. Almost complete series of *Atti* (43 volumes, from 1888 on) and *Archivio Botanico* (22 volumes, from 1925 on) are still available, as well as reprints of the same periodicals, and of *Mycopathologia* and *Il Farmaco*. The Library is also a consulting library of the University of Pavia. Communications should be addressed to the Director, P.O. Box 165, Pavia, Italy.

ERRATUM.—In *Nature*, September 6, p. 326, col. 2, the name of the new assistant superintendent of the Zoological Gardens, London, should be Mr. George S. Canadale.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Sex-linked and Sex-limited White-eyed Mutation of the Blow-fly (*Calliphora erythrocephala*)

DURING the War, the common blow-fly, *Calliphora erythrocephala*, was bred continuously in the laboratory for biological tests in relation to emergency problems. In one of the breeding cages white-eyed females occurred sporadically. This mutation was studied genetically, and it proved to be an interesting case of a sex-linked and sex-limited character. The white-eyed character behaves as a Mendelian recessive and appears only in the double recessive female. Heterozygous females have eyes normal in appearance, and the white-eyed character is never expressed in males although it may be transmitted through them to their female offspring.

Records of breeding experiments involving more than 52,000 descendants of a single white-eyed female show that the mutant gene is located in the *X*-chromosome and that its failure to be expressed in the male, when it is present in that sex in the *X*-chromosome of the *XY* pair, is due to the presence of the dominant allelomorph for normal, wild-type, eye-colour in the *Y*-chromosome. Thus, if white-eyed females are mated with wild-type males, all the F_1 progeny have wild-type eyes; but, if they are inbred, in the F_2 generation there are nearly equal numbers of white-eyed and wild-type females, and all the males are wild-type. If white-eyed females are mated with males bearing the mutant gene in their *X*-chromosome, that is, males from a white-eyed mother, only white-eyed females and wild-type males result in the F_1 generation, and the strain will breed true for successive generations if the progeny are inbred. If wild-type females are mated with males bearing the mutant gene in their *X*-chromosome, all the F_1 and F_2 progeny will have wild-type eyes; but, in the F_3 generation, white-eyed females will segregate out in the proportion of 1 white-eyed female to 7 wild-type females, and, again, all males will be wild-type.

If the *X*-chromosome bearing the mutant gene is denoted by X^w, that bearing the wild-type gene by X^+, and Y^+ denotes the *Y*-chromosome with the wild-type gene, the scheme of inheritance of the mutant gene can be shown diagrammatically as in Tables 1 and 2.

In addition to the well-known series of white-eyed mutants in *Drosophila*, white-eyed mutants have been recorded in other Diptera by Turner[1], in *Psychoda alternata*; by Mackerras[2], in *Lucilia cuprina*; by Dichler[3], in *Phormia regina*; and by Gilchrist and Haldane[4], in *Culex molestus*. In all these cases, however, the mutant genes, which are recessive, appear to be located in autosomes and, except in *Culex molestus* in which there is partial sex-linkage, the mutant characters are not sex-linked. Sex-limitation caused by the presence of a normal allelomorph in the *Y*-chromosome is very rare, and in Diptera it is known only for the character 'bobbed' described in *Drosophila melanogaster* by Mohr[5], and the 'lethal' described by Schubel[6] in the same species. In the case of 'bobbed' the mode of inheritance closely agrees with that now described for the white-eyed mutation of *Calliphora erythrocephala*, except that

TABLE 1. MODE OF INHERITANCE OF THE MUTANT CHARACTER IN THE PROGENY OF A WHITE-EYED FEMALE MATED TO A WILD-TYPE MALE IF THE MUTANT GENE IS LOCATED IN THE *X*-CHROMOSOME AND HAS A WILD-TYPE ALLELOMORPH IN THE *Y*-CHROMOSOME OF THE MALE

X^w = an *X*-chromosome bearing the mutant gene.
X^+ = an *X*-chromosome bearing the wild-type allelomorph.
Y^+ = the *Y*-chromosome of the male with the wild-type allelomorph.

The figures in brackets are the numbers of the different types of flies obtained in a representative breeding experiment.

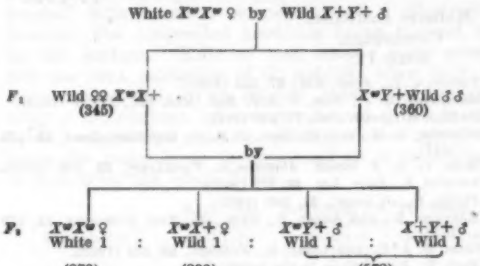
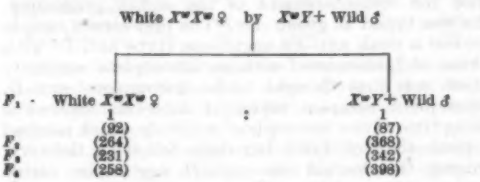


TABLE 2. MODE OF INHERITANCE IN THE PROGENY OF A WHITE-EYED FEMALE MATED TO A WILD-TYPE MALE CARRYING THE MUTANT GENE. THE STOCK WILL BREED TRUE FOR SUCCESSIVE GENERATIONS GIVING WHITE-EYED FEMALES AND WILD-TYPE MALES HETEROZYGOUS FOR THE MUTANT GENE

The figures in brackets are the numbers of white-eyed females and wild-type males obtained in a representative breeding experiment.



crossing-over of the 'bobbed' character between the *X*- and the *Y*-chromosomes has been shown to occur by Philip[7]; whereas in *C. erythrocephala* a white-eyed male has never been found and there appears to be no crossing-over between the *X*- and *Y*-chromosomes, at least between the centromere and the *w*-locus; or it is a very rare occurrence.

This white-eyed mutant of *C. erythrocephala* shows an interesting temperature effect somewhat similar to that described by Ephrussi and Auger[8] for the mutant 'blood' (*wbl*) in *Drosophila*. If pupæ of the white-eyed strain of blow-flies are kept at about + 4° C., and the imagines allowed to emerge at 21° C., the females have eyes of a deeper yellow colour than do females not subjected to cold during pupation. Sometimes imagines actually emerged at + 4° C. when the pupæ had been kept at this temperature for six months or longer. In such females the eyes were tinged with red, and red pigment granules were present in the primary pigment cells. Red pigment has never been seen in mutant females raised at ordinary temperatures, and its development in those kept at + 4° C. suggests that the necessary substrates and enzymes for the formation of the pigment must be present in the mutant eye, but that its development is prevented by an 'inhibitor' such as has been postulated by Crew and Lamy[9] in *Drosophila*. Possibly the 'inhibitor' may be partially inactivated by the low temperature, and this allows the formation of some red pigment to take place.

Owing to the fact that female blow-flies will oviposit in the vicinity of meat which they cannot reach, and when the larvæ hatch they will travel long distances and insinuate themselves through minute

openings to reach the meat, a special technique was developed to prevent contamination of the pure-line cultures. This is described in detail elsewhere[10].

A full account of this work will appear in the *Journal of Genetics*[11]. I wish to thank Dr. D. G. Catcheside, Department of Genetics, Cambridge, for helpful advice and criticism.

P. Tate

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June 11.

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A New Blood Group Antigen, 'Jobbins'

A multiparous woman with seven previous normal pregnancies was first tested serologically eight months after the commencement of the eighth pregnancy. She was typed as group *A rr*. The first serum sample showed a weak anti-*Rh* agglutinin (type anti-*D*) with a titre of 2, associated with an 'incomplete' antibody which was first thought to be 'incomplete' anti-*D*. Subsequent samples taken at intervals showed a rising titre of the 'incomplete' antibody which reached a peak titre of 1,024 ten days following delivery. During this period the anti-*D* agglutinin varied between titres of 1 and 2.

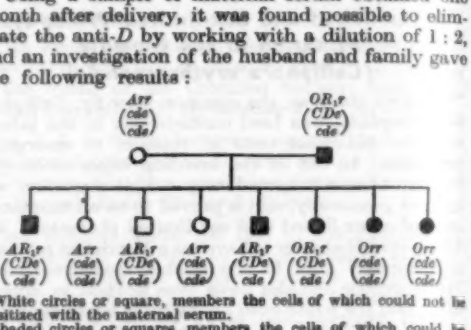
The cord blood of the baby was typed at delivery and was found to be group *O* and negative to anti-*D*, anti-*C* and anti-*E* sera. As at this time it was thought that all the 'incomplete' antibody was 'incomplete' anti-*D*, it was thought possible that the baby was actually *Rh* positive, but that the cell receptors were blocked by the maternal 'incomplete' antibody. Support was lent to this view by the fact that the baby's cells were found to be sensitized by Coombs test[1] and also by the fact that the baby's serum contained the 'incomplete' antibody to a titre of 32.

The child was examined serologically and haematologically at weekly intervals until eight weeks after birth. The blood picture remained normal, and at eight weeks the cells were no longer sensitized when tested by Coombs test. At this point the cells were again typed and found to be negative to anti-*D*, anti-*C* and anti-*E* sera, but positive to anti-*c*. As the cells were no longer sensitized, it was therefore concluded that failure to react with anti-*D*, anti-*C* and anti-*E* sera was not due to blocking of the *Rh* receptors with an 'incomplete' antibody, but because the baby was in fact *Rh* negative (*rr*).

Although the cells were no longer sensitized, it was found possible to re-sensitize them by incubation with the maternal serum for 1 hour at 37° C., the Coombs test on the re-sensitized cells being as strongly positive as the test on the sample taken at delivery. Similar treatment with a high-titre 'incomplete' anti-*D* serum failed to re-sensitize the cells.

These results indicated that the 'incomplete' antibody in the maternal serum consisted not only of 'incomplete' anti-*D*, but also of another antibody independent of the *Rh* system. The *MN* system was excluded by the failure of the maternal serum to sensitize known *Rh* negative *MN* cells, and I am indebted to Dr. R. R. Race for excluding the Lutheran[3], Kell[3], and Lewis[4] antibodies by tests on the cells of mother and baby.

Using a sample of maternal serum obtained one month after delivery, it was found possible to eliminate the anti-*D* by working with a dilution of 1 : 2, and an investigation of the husband and family gave the following results:



White circles or square, members the cells of which could not be sensitized with the maternal serum.
Shaded circles or squares, members the cells of which could be sensitized with the maternal serum.
Black circle, cells sensitized at birth.

Ten random samples of *O Rh* positive cells put up as controls with the diluted serum were not sensitized.

A further sample of the maternal serum obtained six weeks after delivery was tested by Coombs test against a series of 120 *Rh* negative bloods from donors of groups *A* and *O*. None of these bloods was found to be sensitizable with the maternal antibody.

It would therefore seem probable that in view of the failure to sensitize more than a hundred samples of *Rh* negative cells, the antigen is of rare occurrence. It will be seen from the tests on the family that, of the *Rh* negative children, one was found to be sensitized at birth, one was found to be re-sensitizable and two were not re-sensitizable with the maternal serum. The investigation demonstrates a new blood group antigen of rare occurrence, which it is proposed to call the 'Jobbins' antigen, and its corresponding antibody, the antibody being an 'incomplete' form.

It is a pleasure to acknowledge the help of Mr. W. J. Greenwood and Miss J. A. Adkins in the performance of the numerous Coombs tests associated with this investigation.

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[1] Coombs, R. R. A., Mourant, A. E., and Race, R. R., *Brit. J. Exp. Path.*, **26**, 225 (1945).
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Occurrence of *Aspergillus fumigatus* Fresen. in the Lung of an American Bison

The incidence of respiratory mycosis, which has been a frequent cause of deaths among birds in the Zoological Society's Gardens in London for many years, appears to be low in mammals. Scott[1], who studied the association of mycosis and tuberculosis in birds and mammals, recorded mycosis in monkeys and a wallaby; but in these cases, as in most others recorded during the past forty years in the reports of the pathologist to the Zoological Society of London

published annually in the *Proceedings* of that Society, the identity of the fungi involved was not ascertained. *Aspergillus fumigatus* Fresen. is the usual cause of avian mycosis, and it has also been recorded as pathogenic to other animals and to man. The following case of a fatal and apparently uncomplicated mycosis in a bison due to the same fungus appears to be unique.

Case Report. The subject was a male American bison (*Bison bison*) aged about twelve years. He was known to have suffered from shortness of breath and cough each winter for several years. In the autumn of 1946 these symptoms were worse than usual, rapidly developed into respiratory distress, and the animal died in a few days. At necropsy next morning, a few old adhesions were found in the pleuræ and pericardium. All the air-passages, from the largest just below the vocal folds in the larynx, to the smallest that could be seen with the naked eye, appeared to be lined with a thick-piled, green-grey velvet, evidently a mycotic mycelium. The air-passages did not appear to be dilated. The intervening lung showed a moderate degree of fibrosis only, and this was confirmed on section. No other abnormality was found in any organ.

Isolations from the lining of the air-passages yielded pure cultures of *A. fumigatus*.

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London School of Hygiene and Tropical Medicine.

July 18.

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Insecticidal Effect of Surface Deposits of D.D.T. on Mud

Observations in the field[1,2] have shown that mosquitoes become affected after making contact with D.D.T.-treated surfaces in rooms and may make their escape through open doors and windows. Kennedy[3] has shown in the laboratory that sub-lethal doses of D.D.T. excite mosquitoes, and that when activated they move preferentially to light. For residual spraying in houses to be successful in reducing the incidence of malaria, it is essential, therefore, that the surface deposit applied shall be lethal to mosquitoes after only a brief contact.

The types of surface most common in African houses are the mud wall and the thatch roof. Laboratory tests have been conducted to determine the efficacy of various D.D.T. formulations on mud. Sun-dried soil, passed through a 40-mesh sieve, was made into standard mud blocks 2 in. square by 1 in. deep in wooden frames and allowed to dry slowly at room temperature. Each formulation contained 5 per cent D.D.T. (*pp'*) and was applied at dosages ranging from 100 to 400 mgm. per sq. ft. with a Four Oaks 'Kent' Sprayer to 5 × 4 blocks. 24 hours later, biological toxicity tests were carried out with *Glossina palpalis* and *Aedes ægypti* as test insects. The outer layer from each set of four blocks was then scraped off and made up to 1 gm. in weight, this representing a layer of approximately 0·1 mm. in thickness. Chemical determinations of the insecticidal deposit in this layer and in the whole blocks were made, using the dehydrohalogenation method. This outer layer contains more than all the contact available insecticide.

Oil solutions were absorbed into the mud to a considerable extent, only 6–15 per cent of the insecticide appearing in the outer layer, and mortality of test insects was low. Even with dosages so high as 1,000 mgm. per sq. ft., the proportion in the outer layer was not increased and kills remained low.

The highest proportion of insecticide recovered from the outer layer (62 per cent) was from blocks treated with a water suspension of a dispersible powder, the suspended particles being filtered off at the surface. Kills of test insects were good; 100 per cent mortality of *G. palpalis* after only 15 sec. contact and up to 90 per cent of *A. ægypti* after ½ hr. contact. Some results are given in the table, where the amount of insecticide recovered from the outer layer is expressed as a percentage of that from the whole block.

Formulation	Mean percentage of D.D.T. in outer 0·1 mm.	Percentage kill *G. palpalis* after contact of 15 sec.	15 min.	Percentage kill *A. ægypti* after contact of 1 hr.
Solution of D.D.T. in :				
Diesoline	8	0	5	10
Kerosene	13	0	20	10
50 per cent kerosene and 50 per cent cotton seed oil	11	0	25	10
Cotton seed oil	10	0	15	10
Emulsion :				
T.P. 543	35	25	75	70
T.P. 543 + Resin	27	5	50	43
Dispersible powders :				
Geigy Neocid *BA*50	46	100	—	100
Hyg. Chem. Co. *N*210	62	100	—	100

76 per cent of a 'Gammexane' dispersible powder 530 was recovered from the outer layer a few hours after application, but the percentage fell to 20 per cent in 10 days.

Details of these tests will be published later. Field trials using dispersible powders for residual spraying in houses are in progress.

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June 25.

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Alloxan Diabetes and Glycogen Phosphorolysis in Rats

Laszt and Vogel have reported[1] that they found "that the rate of glycogen phosphorolysis in muscles of alloxan-diabetic rats was increased by 63 per cent after 15 minutes and by 69 per cent after 30 minutes incubation time. By adding insulin *in vitro*, the rate of glycogen phosphorylation is diminished."

The number of experiments and the quantity of insulin used in this work are not stated. Since this result would not only add to our understanding of the action of alloxan but also of the possible connexion of insulin with phosphorylation, we repeated these experiments on ten normal and eight alloxan-diabetic rats, but failed to confirm it.

The following are mean values of the percentage decrease of inorganic phosphate (method of Lohmann and of Verzár and Montigel) if muscle or liver are brought together with glycogen. The diabetic rats were poisoned with alloxan (Roche, new preparation) and suffered from diabetes for one to three months, with 5–7 gm. glucose daily in 60–110 c.c. of urine. Insulin 'Berna' was used, diluted 25–250 times.

PERCENTAGE DECREASE OF INORGANIC PHOSPHORUS (MEAN VALUES)*

	After minutes	Without addition %	σ	With 8 units insulin per 100 gm. %	σ	With 80 units insulin per 100 gm. %	σ
Muscle of 10 normal rats	7	24	2·7	22	3·3	16	3·9
	15	42	3·6	42	4·0	32	4·1
	30	65	5·3	64	6·4	51	5·8
Muscle of 8 alloxan-diabetic rats	7	22	2·2	21	2·1	16	1·7
	15	41	7·9	41	5·0	32	4·0
	30	63	5·3	62	9·0	49	7·2
Liver of 10 normal rats	7	11	1·4	11	0·8	8	1·1
	15	21	2·0	21	1·8	16	1·6
	30	32	3·2	32	2·2	24	2·6
Liver of 8 alloxan-diabetic rats	7	10	2·5	11	2·1	8	1·5
	15	21	4·6	20	3·0	16	2·7
	30	30	3·4	31	5·2	23	2·8

* $\sigma = \pm \sqrt{\frac{sd^2}{n(n-1)}}$

Thus (1) glycogen-phosphorylation by muscle and liver is not increased in alloxan-diabetic rats as compared with normal rats; (2) insulin has in very high doses (of 80 units/100 gm.) a depressing effect on glycogen phosphorylation with muscle and liver of normal animals; (3) there is no difference between the action of insulin in the glycogen phosphorylation of alloxan-diabetic and that in normal animals.

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[1] *Nature*, **158**, 583 (1946).

Decrease in the Arginase of the Liver and Mammary Gland in Adrenalectomized Lactating Rats as Compared with Pair-fed Controls

ADRENALECTOMY causes a decrease in the arginase activity of the liver[1,2] and lactating mammary gland[3] in the rat. These findings, together with complementary observations on the abilities of various adrenal cortex steroids to restore the depleted tissue arginase levels after adrenalectomy[1,2], are of great interest in view of the fact that it is now believed[3] that certain cortical hormones promote gluconeogenesis from protein, a process entailing deamination of amino-acids and the excretion of the nitrogen as urea through the ornithine cycle which, of course, involves the action of arginase.

Adrenalectomy is usually followed by a reduction in food intake[4], and it is obviously desirable to show that the changes in tissue arginase levels following adrenalectomy are not secondary consequences of this anorexia. We have essayed to do this by means of the paired-feeding technique.

Fifteen pairs of lactating rats were used, one member of each being adrenalectomized on the fourth day of lactation, the other being subjected to a sham operation. Thereafter the daily food intake of each sham-operated control was restricted to that of its adrenalectomized partner. The rats were killed on the seventeenth day of lactation and the arginase activities of the livers and mammary glands estimated as described previously[5], but using an improved method for arginase determination similar in principle to the colorimetric method of Van Slyke and Archibald[6]. The present arginase units thus differ from those used in our previous publications[2,5].

The mean liver arginase activity per gm. moist tissue for the adrenalectomized rats was 170 ± 13·7 units as compared with 770 ± 25·3 for the pair-fed controls. For mammary tissue the values were 8·4 ± 0·58 and 46·4 ± 2·48 units respectively. Differences of a similar order were observed when the results were calculated on a basis of total arginase activity per 100 gm. rat. There can be no possibility that these differences were due to changes in the activation of the enzyme, since parallel estimations of arginase activated fully by manganese sulphate revealed similar differences, though the arginase activities were now some four to five times higher.

The interpretation of the results of experiments involving the equalized food intake technique may often be more difficult than appears at first sight, particularly as in the present instance, when reduction of the food intake of the controls (which suffered a much greater loss in body-weight than their adrenalectomized partners) led to increased tissue protein catabolism, in face of which the liver arginase levels might tend to be maintained[7]. But the present results do show that the anorexia resulting from adrenalectomy is not the direct cause of the reduction in the tissue arginase levels which follows this operation. It must be noted that neither these experiments nor their predecessors[1,2] give any information as to whether or not the adrenal cortex exerts a direct effect on tissue arginase.

These experiments, which belong to a series in which Messrs. A. T. Cowie and T. H. French also collaborated, will be reported in more detail elsewhere.

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July 16.

[1] Fraenkel-Conrat, H., Simpson, M. E., and Evans, H. M., *J. Biol. Chem.*, **147**, 99 (1943).
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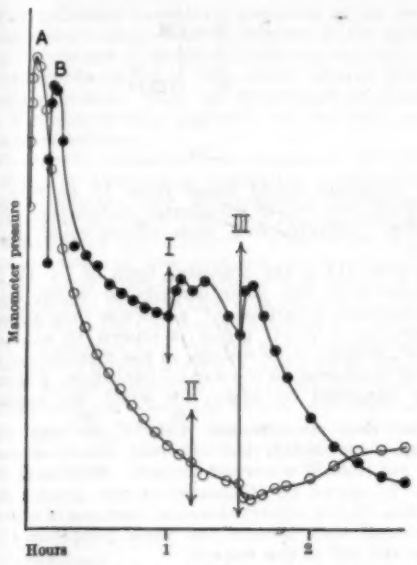
Shock-induced Stomatal Movements

IT is now usual in stomatal investigation to affix a porometer cup by lightly clamping the leaf between a glass plate and a glycerol-gelatin washer greased with a beeswax-'Vaseline' luting-wax; this is in essence the method used by Heath[1] in his critical study of the resistance porometer. As is well known, the mechanical shock attendant on the fixing of such a cup induces almost instantaneous partial closure of the stomata in certain plants, of which *Pelargonium zonale* is one. The typical effect is shown in the accompanying figure: Record *A*, from the beginning of the record to the point II. This represents the 'recovery curve' of the stomata of *P. zonale* in continuous light after the attachment of a porometer cup, taken with a simple form of resistance porometer[2]; increasing manometer pressure corresponds to stomatal closure. It has for long been assumed that this smooth opening curve does, in fact, represent 'recovery', and that when the stomatal resistance has fallen to a conveniently low value (one to two hours being usually allowed) the stomata may be assumed to be in a substantially normal state. However, in the course of an investigation into the characteristics of shock-induced movements, an unexpected phenomenon has been en-



countered which throws doubt on the validity of this assumption.

It is possible, by preparing a luting-wax of suitable consistency, to obtain an airtight seal to the gelatin washer without the use of the glass plate. Record *B* in the figure represents the stomatal behaviour under a porometer cup so attached to the leaf upon which Record *A* was being taken simultaneously. It is clear that, although the interference with normal conditions is presumably less than with the orthodox method of attachment used for *A*, the stomata under *B* are opening less completely and somewhat irregularly. At I the leaf at *B* was subjected to a mechanical shock approximately similar in nature and magnitude to that which it would receive in the course of attachment of a cup; there is a slight reaction, but it is clear that full sensitivity has not yet been regained. At II, *A* received similar treatment, and it will be observed that the stomata under this cup, though appearing from the lower stomatal resistance to be more completely 'recovered' than at *B*, are, in fact, completely insensitive to shock. This suggests that the 'normal recovery curve' of *A* is rendered possible by some active inhibition of the shock reaction, produced by the presence, and presumably the pressure, of the glass. (The glass does not, of course, press directly on the stomata under investigation, but is nevertheless the cause of a slight deformation of the epidermis.)

In order to test this hypothesis, the glass plate was removed from *A* and a similar plate clamped in the usual position on *B* (point III on the diagram). The immediate effect is a slight rise in apparent resistance for *B* and a similar drop for *A*, to be expected since the plate introduces a small additional resistance to air flow. The further effects are striking; *B* for the first time promptly assumes the 'normal recovery' opening movement; and the stomata of *A* begin, slowly and irregularly, to close slightly.

As is usual with irritability phenomena, the behaviour of a leaf in this respect appears to depend on many factors, and this particular response has not been elicited in every case; it has, however, been observed on a number of occasions in plants of diverse origin, and its existence is regarded as satisfactorily established. It appears, therefore, that the behaviour of stomata under observation within this type of porometer cup cannot, so far as shock sensitivity is concerned, be regarded as normal. Whether they may be assumed to be reacting normally to light-dark stimuli depends on whether the mechanisms of movements induced by shock on one hand, and by changes in light intensity on the other, can be regarded as completely independent. Such results as have been obtained to date suggest that the two mechanisms, though commonly manifested separately, are not, in fact, independent; but this point is being investigated further.

A more detailed account of these phenomena will be published in due course.

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June 10.

[1] Heath, O. V. S., *Ann. Bot.*, N.S., **5**, 455 (1941).
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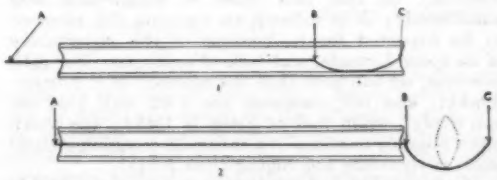
An Ensheathed Rotating Knife for Causing Brain Lesions

When studying the effects of coagulation lesions caused by high-frequency alternating current passing through electrodes in the brain of monkeys, we often noticed that the injury was not confined to the needle tip, but extended along the needle. This additional damage was caused by gas bubbles arising from the point of coagulation from the high temperature of the needle, even when the current was passed for only 10 sec., and from the irregular distribution of the current. The use of direct current often avoids this trouble but has other disadvantages. To avoid the use of electrodes altogether we found the following purely mechanical cutting instrument useful.

The instrument of the type used at present consists of a suitable length of hypodermic needle tubing, of diameter 1½ mm., in which is concealed a spring steel knife as shown in Fig. 1. When the needle has been inserted into the brain to the required depth the spring steel knife is pushed out and the centre point of the knife moves laterally (see Fig. 2). If the knife is now rotated there is a spherical area of brain tissue cut out.



This instrument is particularly useful for mid-line lesions of the thalamus. The inter-hemispheral fissure allows a deep penetration of the outer carrying cylinder down to the dorsal surface of the thalamus without causing any cortical damage. Even if cortical tissue has to be passed through, the damage is never considerable, while the mechanically operated curved knife always causes a well-defined lesion of a suitable size, in contrast to electrically caused injuries, the extent of which is always difficult to control.

The passing of the instrument can be operated from any fixed holder, or it can be fitted to the customary types of stereo-taxic instruments.

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P. D. WALL
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June 13.

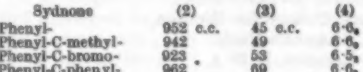
Sydnones

THE total polarizations (col. 2) of six sydnones, determined in benzene solution at 25°, are recorded in the following table, with the dipole moments (col. 4) estimated therefrom by the refractivities shown (col. 3):

Sydnone	(2)	(3)	(4)
N-Phenyl-	952 c.c.	45 c.c.	6·6$_0$ D.
N-Phenyl-C-methyl-	942	49	6·6$_5$
N-Phenyl-C-bromo-	923	53	6·5$_5$
N-Phenyl-C-phenyl-	962	69	6·6$_4$
N-Benzyl-	808	49	6·0$_4$
N-β-Naphthyl-	1045	63	6·9$_2$

These results are of interest in relation to the structure and formulation of this series of compounds[1-3]. The insensitivity of the moments to the replacement of one substituent by another is a notable feature. To test whether the moments of the C-methyl- and C-bromo-derivatives are the resultants of that of N-phenyl sydnone and the usual vectors for C—Me and C—Br links respectively, the inclination, θ (expressed in degrees clockwise), of the 'parent' moment toward the C—Me or C—Br axis may be calculated. If μC—Br is 1·5D., θ is 102°; if μC—Me (a less certain quantity than that for C—Br) is between 0·3 and 0·4D., θ varies from 77–80°; θ is evidently *not* constant. The argument parallels that applied to quinoline[4] and suggests, qualitatively, the occurrence of mesomerism[5].

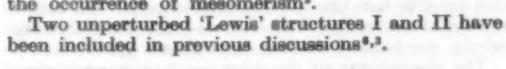
Two unperturbed 'Lewis' structures I and II have been included in previous discussions[2,3].



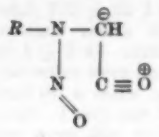
(I) (II)

The first was suggested with reservation when the discovery of this new class of compounds was announced[6]; it is difficult to compute the moment to be expected for it, because of the uncertainty of its space formula, and lack of analogies. For (II), however, we can note that the moment of N-nitroso-methyl- and ethyl-anilines are 3·62 and 3·61 respectively[7], while that of keten is 1·45[8]; the maximum possible moment of a molecule combining these units is therefore not higher than 5·1D.

If the stable hybrid is imagined as a roughly regular 5-ring, many fully polar forms (for example, III, IV, V and VI) may contribute.



(III) (IV) (V)



(VI)

Their moments would range from 12 to 20D. in magnitude and be well distributed in direction. It is therefore creditable that their effects could nearly cancel.

Formula III is the activated form of I; IV has analogies with the polar contributor which raises the observed polarities of α-pyrone derivatives[9]; further, the —N=O group is known to act as a 'donor', forming 5- or 6-rings, in the metallic derivatives of 'cupferron' or the nitroso-naphthols. Formula VI is suggested by keten, for which an assumed 25 per cent contribution $\overset{\ominus}{C}H_2—C\equiv\overset{\oplus}{O}$ has been necessary to explain the observed dipole moment *vis à vis* that of a normal ketone. Structures (II) and (VI) cannot be eliminated on the ground that sydnones do not exhibit chemical reactions of nitroso-compounds, since some of the metal complexes cited above also fail in this respect.

Finally, we think it unlikely that some mesomeric shifts are not also occurring in the aryl radicals of the sydnones. Quadripolar forms might therefore further affect the measured moment. In this respect, the low moment of N-benzylsydnone (where conjugation with N is broken by interpolation of $>CH_2$) and the high moment of the naphthyl derivatives may be significant.

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[1] Baker and Ollis, *Nature*, **158**, 703 (1946).
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[3] Earl, *Nature*, **158**, 909 (1946).
[4] Le Fèvre and Le Fèvre, *J. Chem. Soc.*, 1470 (1935).
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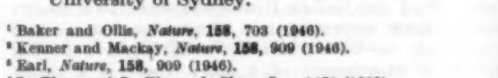
Dipole Moments and Structure of the Sydnones

THE letter by W. Baker and W. D. Ollis[1] concerning the structure of the sydnones, for example, N-phenyl-sydnone (I)[2], led to a joint programme of work being undertaken at Bristol and Oxford. As J. C. Earl and R. J. W. Le Fèvre kindly informed us that they had also been engaged upon a similar task and have given us their results, which are in large measure complementary to ours, it seems opportune to record our findings.



(I) (II)

Two sydnones have been prepared which possess no aromatic nucleus directly attached to the sydnone ring. These are N-*cyclo*hexylsydnone, m.p. 64°, and N-benzylsydnone, m.p. 70°, which behave like the N-aryl-sydnones. They are hydrolysed by alkali to the N-nitroso-N-alkyl-glycines, and by acid to the N-alkylhydrazines.

The dipole moments were measured in benzene at 25°. For determining orientation polarizations at infinite dilution, the extrapolation procedure of Hedestrand[3] was used, with the refinements suggested by Halverstadt and Kumler[4]. These show that the negative pole of the sydnone group moment is directed away from the benzene ring in the N-aryl-sydnones, and indicate that it is within 17° of being collinear with the C—N bond between the two rings, since the moments of toluene and of chlorobenzene in benzene as solvent are 0·4 D. and 1·55 D. The large dipole moments exclude the possibility that the sydnone ring has solely the bicyclic structure originally suggested[5], since in that case the magnitude of the moment of N-phenylsydnone would be not greater than that found for a γ-lactone (4·12 D.)[6].

	P_∞	P_E	μ
N-Phenylsydnone	910·2	46·1	6·50
N-*p*-Tolylsydnone, m.p. 144–145°	1032·4	50·7	6·93
N-*p*-Chlorophenylsydnone, m.p. 113°	518·4	54·8	5·04
N-*Cyclo*hexylsydnone	941·8	46·5	6·62

Support is thus given to the view[1] that the sydnones have mesomeric structures derived from polar components, though the possibility that the original bicyclic structure makes some contribution cannot be entirely ruled out. It is not a simple matter to assess the relative importance of individual contributing polar structures because they are numerous (allowing $R—N <$ or $R—\overset{+}{N} \leqslant$; —N=, —$\overset{-}{N}$— or —$\overset{+}{N}$—; —O— or —$\overset{+}{O}$=; —CH=, —$\overset{+}{C}$H—, or —$\overset{-}{C}$H—, and $> C=O$ or $+ > C—\overset{-}{O}$, there are eight dipolar structures, and also quadripolar ones). Furthermore, the real moment which would result from a formal charge transfer cannot be accurately predicted; it will probably be less than the formal charge transfer moment. This discussion will, therefore, be left for fuller publication, but it may be noted that structures in which the nitrogen of the *R*—N group is positive and tetravalent must make a considerable contribution.

The small increase of moment when the N-phenyl group is replaced by the N-*cyclo*hexyl group may indicate a small participation by polar structures involving the benzene ring: in this connexion N-*cyclo*hexylsydnone decomposes slowly in benzene solution at 25°, whereas N-phenylsydnone is stable. The effect may, however, be due to dipole induction without conjugation.

The sydnones form a special case of a group of related cyclic molecules for which covalent formulations appear in greater or lesser degree improbable and for which no single polar structure is satisfactory. They conform to the general formula (II), where X = CH, C*R*, or N; $Y—Z$ or $Z—Y$ = —O.CO—, —N*R*.CO—, —O.C(:N*R*)—, or —N*R*.C(:N*R*)—, and the related thio derivatives. Most of these are as yet unknown, and many may be incapable of existence, but known examples are the reagent 'nitron' (μ = 7·2 D.[7]), and certain '*endo*thiodihydrothiodiazoles'[8], for which zwitterionic hybrid formulæ were suggested by Schönberg in 1938[9]. In addition, $Y—Z$ may form part of a benzene ring, in which case *R*—N may also be represented by O (as in benzfurazane), S or Se (as in piazthiole and piaselenole)[10]. Search for new compounds of these types is being made.

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[2] The symbol ± was suggested by Simpson, J. C. E., *J. Chem. Soc.*, 95 (1946).
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[4] Halverstadt, S. F., and Kumler, W. D., *J. Amer. Chem. Soc.*, **64**, 2988 (1942).
[5] Earl, J. C., and Mackney, A. W., *J. Chem. Soc.*, 899 (1935). Earl, J. C., and Eade, R. A., *J. Chem. Soc.*, 591 (1946).
[6] Marsden, R. J. B., and Sutton, L. E., *J. Chem. Soc.*, 1383 (1936).
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[9] Schönberg, A., *J. Chem. Soc.*, 824 (1938). See also Jensen, K. A., and Friediger, A., *Kgl. Danske Videnskab. Selskat, Math.-fys. Medd.*, **20**, 1 (1943); see *Chem. Abs.*, **39**, 2068 (1945).
[10] Baker, W., *J. Chem. Soc.*, 267 (1945).

Structure of Cyclopropane and Ethylene Oxide

IT is of interest to consider the results of applying the non-localized molecular orbital theory, as developed largely by Mulliken, Lennard-Jones and Hund, to the problem of the structures of cyclopropane and ethylene oxide, concerning which there has recently been some controversy[1,2,3]. The fundamental point of the theory is that any molecular orbital, which may be bonding or otherwise in all the nuclei, must conform to an irreducible representation of the point group of the nuclear skeleton. The case of the equilateral triangle, important for cyclopropane, has been touched on by Mulliken[4], who shows that for any given type of orbital of X in X_3 (point-group D_{3h}) it is possible to construct two such orbitals with the following eigenfunctions:

$$\psi = \frac{1}{\sqrt{3}}(\psi_1 + \psi_2 + \psi_3) \quad \text{Representations } a'_1, a'_2, a''_2$$

$$\psi = \begin{cases} \dfrac{1}{\sqrt{2}}(\psi_1 - \psi_3) \\ \dfrac{1}{\sqrt{6}}(\psi_1 + \psi_3 - 2\psi_2) \end{cases} \quad \text{Representations } e', e'' \text{ (doubly degenerate)}$$

The suffixes refer to any particular X in the triangle, in this case X being CH_2; before building up the cyclopropane structure, the orbitals of CH_2 will be reviewed[5]. They are formed from linear combinations of *H*1*s* and *C*2*s*, 2$p_{x,y,z}$ orbitals, the basic symmetry being C_{2v} and the orbitals resulting being shown diagrammatically in Fig. 1. In the designations the first letter denotes the basic *C* orbital and the second the representation. The divalent state is then $(sa_1)^2\,(yb_2)^2\,(za_1)(xb_1)$, the xb_1 being non-bonding in CH_2, and za_1, yb_2 strongly bonding.

These CH_2 orbitals are now to be used as basic orbitals for constructing $(CH_2)_3$ orbitals, the *z*-axis in each group being directed to the centre of the triangle with *y*-axis perpendicular to the plane of C_3. The resultant orbitals in the case of the xb_1 electrons

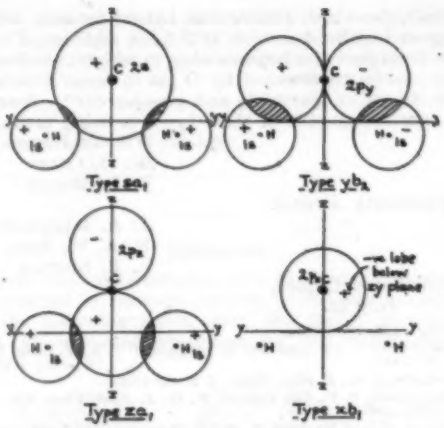

Fig. 1. CH_2 ORBITALS
Shaded areas represent ☰ bonding

are shown diagrammatically in Fig. 2, as deduced from the above equations, the second letter now referring to the particular representations of the point-group D_{3h}.

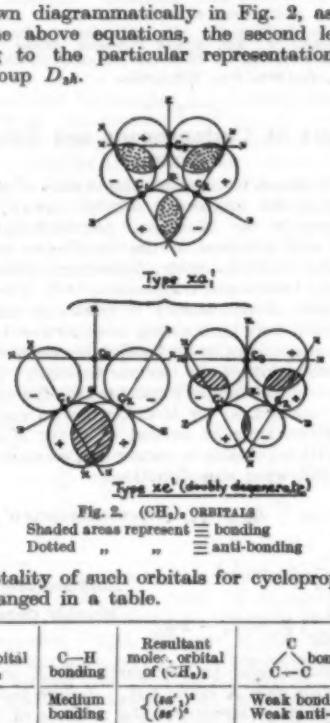

Fig. 2. $(CH_2)_3$ ORBITALS
Shaded areas represent ☰ bonding
Dotted " " ☰ anti-bonding

The totality of such orbitals for cyclopropane has been arranged in a table.

Molec. orbital of CH_2	C—H bonding	Resultant molec. orbital of $(CH_2)_3$	C⟨ ⟩C bonding
sa_1	Medium bonding	$\begin{cases}(sa'_1)^2\\(se')^4\end{cases}$	Weak bonding Weak anti-bonding
yb_2	Strong bonding	$\begin{cases}(ya''_2)^2\\(ye'')^4\end{cases}$	Weak bonding Weak anti-bonding
za_1	Strong bonding	$\begin{cases}(za'_1)^2\\(ze')^4\end{cases}$	Strong bonding Strong anti-bonding
xb_1	Non-bonding	$\begin{cases}(xa'_2)^2\\(xe')^4\end{cases}$	Strong anti-bonding Strong bonding

The eighteen valency electrons will occupy the lowest places in these in the ground-state, giving cyclopropane the structure :

$$(sa'_1)^2\ (se')^4\ (za'_1)^2\ (ya''_2)^2\ (xe')^4\ (ye'')^4\ ;\ {}^1A'_1.$$

The main C ring bonding is due to $(za'_1)^2$ and $(xe')^4$, the y (usually called π) electrons having a negligible effect, or if at all, antibonding, so that there appears to be no complex of this type. The question of how to write a complete structural formula for cyclopropane indicates the general inadequacy of the usual simple bond models, which remain, however, adequate for most purposes; the above analysis, although only qualitative, is such that the general effect of all the electrons is indicated. It is at present impossible to plot contours of equal electron density or lines of force in such a case as cyclopropane. Fig. 3 shows roughly the relationship of this treatment to Walsh's concept of a distorted ethylene.

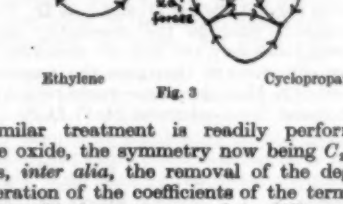

Fig. 3

A similar treatment is readily performed for ethylene oxide, the symmetry now being C_{2v}, which involves, *inter alia*, the removal of the degeneracy and alteration of the coefficients of the terms of the molecular orbitals on account of the different electronegativities of CH_2 and O. Orbitals belonging to the same representation will hybridize with each other to give the minimum energy state.

The above method has the advantage of not introducing the artificial 'resonance' idea with unsymmetrical canonical structures.

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[1] Walsh, *Nature*, **159**, 165 (1947).
[2] Robinson, *Nature*, **159**, 400 (1947).
[3] Walsh, *Nature*, **159**, 713 (1947).
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[5] Lennard-Jones, *Trans. Farad. Soc.*, **30**, 70 (1934).

Geometrical Configuration of Dialkyl Naphthenes

PRESENT information on the spatial configuration of the dialkyl cyclopentanes and cyclohexanes is unsatisfactory. Zelinsky[1] concluded from the result of an asymmetric synthesis that the lower-boiling isomer of 1 : 3-dimethylcyclohexane had the *trans* configuration, and following on this later workers have assigned the *trans* structure to the lower-boiling isomers of naphthenes. Mousseron and Granger[2] carried out a more reliable asymmetric synthesis of 1 : 3-dimethyl-cyclohexane and showed that the higher-boiling isomer was optically active and therefore of *trans* configuration. Chiurdoglu[3] afterwards compared the relative rates of oxidation and bromination of the spatial isomers of various 1 : 2-dialkylcyclopentanes, and found that the higher-boiling isomers possessed the greater reactivity. It was also found that *trans* 1 : 3-dimethylcyclohexane, as determined by Mousseron and Granger (*loc. cit*), and *trans* decalane reacted more rapidly with the above reagents than did their *cis* isomers. Chiurdoglu, therefore, concluded that the higher-boiling isomers of the 1 : 2-dialkylcyclopentanes had the *trans* configuration. Pitzer and Beckett[4], in a recent investigation of the theoretical and calculated entropies of the

dimethylcyclohexanes, concluded that the nomenclature of the 1 : 3-dimethylcyclohexanes should be reversed and that the higher-boiling isomer should be regarded as the *trans* isomer. This result is thus in agreement with that obtained by Mousseron and Granger (*loc. cit.*).

Only one isomer of 1 : 3-dimethylcyclopentane has been reported in the literature, and this has been assigned the *trans* configuration on the basis of the work of Zelinsky (*loc. cit.*). Preparations of this naphthene from 1 : 3 : 5-xylenol have resulted in the production of a hydrocarbon corresponding in properties to those of the known hydrocarbon, and have not given the expected mixture of *cis* and *trans* isomers. There was some evidence from infra-red spectra that a second isomer might be present in the slightly higher-boiling tail-ends from the fractionation of the main product, but no pure compound could be isolated from the small quantities of material available.

A synthesis of *cis* 1 : 3-dimethylcyclopentane was therefore attempted using cyclopentane-*cis*-1 : 3-dicarboxylic acid as starting material. A paper describing the preparation of this acid has been accepted for publication in the *Journal of the Chemical Society*. The synthesis involved the reduction of the diethyl ester of this acid to 1 : 3 : di(hydroxymethyl)cyclopentane, replacement of the hydroxyl groups by halogen and reduction of the dihalide to the hydrocarbon. The hydrocarbon thus obtained was identical with the known 1 : 3-dimethylcyclopentane. No evidence was obtained for the presence of a second isomer in this product.

Two possible explanations of this observation suggest themselves. Either isomerization to the *trans* form takes place at some stage in the above synthesis from the *cis* acid, or the hydrocarbon previously referred to as *trans* is, in fact, the *cis* isomer. The apparent closeness of the boiling points of the isomers of 1 : 3-dimethylcyclopentane throws some doubt on the value of Zelinsky's determination of the *trans* isomer, and in view of the work of Chiurdoglu (*loc. cit.*), the known lower-boiling isomer may be the *cis* hydrocarbon. Our observations tend to support this view.

To gain additional information on this point a synthesis of 1 : 3-dimethylcyclopentane from cyclopentane *trans* 1 : 3-dicarboxylic acid is being attempted in this laboratory. The product will be compared with the hydrocarbon obtained from the *cis* acid.

The possibility of selective adsorption of one of the optical enantiomorphs of the *trans* form of dimethylnaphthenes on an optically active adsorbent is also under investigation. The isomer which develops optical activity after such treatment must be the *trans* isomer, since the *cis* compound cannot exist in active forms.

We wish to thank the chairman of the Anglo-Iranian Oil Co., Ltd., for permission to publish this note.

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[2] Mousseron and Granger, *Bull. Soc. Chim. France*, **5**, 1618 (1938).
[3] Chiurdoglu, *Bull. Soc. Chim. Belg.*, **53**, No. 3, 45 (1944).
[4] Pitzer and Beckett, *J. Amer. Chem. Soc.*, **69**, 977 (1947).

Configuration and Packing of Chain Molecules of Native Starch in the *B*-Modification

In a previous communication[1] I mentioned the dimensions of a unit cell of native starch in the *B*-modification as deduced from a fibre pattern obtained from a part of a single starch grain. It has now become evident, from consideration of the reciprocal lattice and reflexion globe, that the unexplained difference, noted in that communication, between the fibre period calculated from the pattern and the supposed true period, is a phenomenon that may be expected and that can be explained from bad parallelism between the micelles, especially from those directions of the micelle long axes which deviate from perpendicularity to the incident beam. Furthermore, a critical revision of the *d*-values derived from a powder pattern of native starch in the *B*-modification has shown that a fibre period of 10·5–10·6 A. is in somewhat better agreement with these spacings than the period of 10·4 A. previously given.

It was originally suggested[1] that the fibre period would contain two pyranose rings, as in cellulose and chitin. Further investigation has shown, however, that there are a number of arguments for rejecting this idea in favour of a chain containing three glucose units in the period, in spiral arrangement.

As distinct from the substances mentioned above and from alginic acid (see Astbury[2]), in which pyranose rings are united in β-1 : 4 linkage, the starch chain is considered to consist of glucose units in α-1 : 4 linkage (see, for example, K. H. Meyer[3]). This α-linkage gives difficulties when constructing for starch a chain configuration similar to those assumed in cellulose and alginic acid. A flat and straight, strainless chain of α-glucose units, for example, with two units per period, will, though it can be constructed in different ways, always show a much shorter period than 10·6 A. Furthermore, the X-ray density of starch, calculated from a unit cell of the dimensions suggested[1] and filled up with chains with two glucose units per fibre period, cannot be brought into accordance with the experimental density of starch as determined under water[1], which latter should be lower than the X-ray density and not equal to it.

The proposed chain, with three glucose units per period of 10·6 A., in three-fold screw arrangement, is strainless and continues in a constant direction. The dimensions of the projection of such a chain on the basal plane are in accordance with the dimensions and the hexagonal ratio I found for the axes in this plane[1]. Assuming a rhombohedral or hexagonal unit cell in which $a = 18{\cdot}1$ A. (the double length of the shortest orthorhombic axis[1]), enclosing twelve such chains (and containing thirty-six glucose units) with one water molecule per glucose unit, the X-ray density would be reconcilable with the experimental density.

Details will follow elsewhere.

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[1] Kreger, D., *Nature*, **158**, 199 (1946).
[2] Astbury, W. T., *Nature*, **155**, 667 (1945).
[3] Meyer, K. H., "Natural and Synthetic High Polymers" (New York, 1942), 393.

The Thermochor, a New Additive and Constitutive Property

By analogy with perachor and rheochor, I suggest the name 'thermochor', symbol $[T]$, for the relation $(V^{2/3}\ T^{1/4})$, between the molecular volume and the temperature at the boiling point, which has been deduced in the following manner.

Near the boiling point, the relation between the molar latent heat and the internal molar latent heat is: $L = L_i + RT$ (1). By substituting this expression for L in the Trouton formula $L/T = 21$ (2), and assuming $R = 2$, we obtain

$$\frac{L_i + RT_b}{T_b} = \frac{L_i}{T_b} + 2 = 21. \qquad (3)$$

Hence $$L_i/T_b = 19. \qquad (4)$$

But L_i is roughly proportional to the free molar surface energy[1] ε:

$$L_i = k\varepsilon \quad (5); \qquad \varepsilon = \gamma V^{2/3} \simeq \gamma \left(\frac{M}{D-d}\right)^{2/3}, \quad (6)$$

where γ is the surface tension, V the molecular volume, M the molecular weight, $(D-d)$ the difference between the density of the liquid and its vapour.

Substituting for ε in equation (5) the value obtained in equation (6), we have $L_i = k'\gamma V^{2/3}$.

Hence $$\frac{\gamma V^{2/3}}{T_b} \simeq \text{constant}. \qquad (7)$$

This relation is in rough accordance with experimental data, but is more accurate than Trouton's law for normal liquids, and if γ is measured in dynes per cm., V in cubic centimetres, at the boiling point in absolute temperature T_b we have:

$$\frac{\gamma}{T_b}\left(\frac{M}{D-d}\right)^{2/3} \simeq \frac{\gamma V^{2/3}}{T_b} \simeq 1{,}085. \qquad (8)$$

Now taking the Sugden equation for the parachor:

$$\left(\frac{M}{D-d}\right)^{2/3} \gamma^{1/4} = [P], \qquad (9)$$

and by elimination of γ using (8) and (9):

$$[T] \simeq \left(\frac{M}{D-d}\right)^{2/3} T^{1/4} \simeq V^{2/3}\,.\,T^{1/4} = \frac{1}{1{,}055}\,[P]. \quad (10)$$

There is a certain linear relationship between the property thus determined and the parachor, a relationship for which I propose the name of 'thermochor' and which has been found to agree very well with experimental data, so long as the parameter for each atom or constitutive contribution is used for the purpose of calculation. I hope to publish elsewhere[1], at a later date, the results of many examples of the application of this formula.

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[1] Carvalho, H. G. de, *An. Acad. Brasil. Cien.*, in the press.

Spectrum of ρ Cassiopeiæ

The spectrum of the irregular variable ρ Cassiopeiæ has been variously classified as *G7* (Victoria), *cG0* (Mt. Wilson), *F8p* (Yerkes) and *F8p* (Harvard), the last classification being accompanied by the note "the spectrum resembles class *K0* in the region of *Hβ*". The classifications agree in attributing the spectrum to a supergiant with a luminosity about 1,500 times that of the sun, while the surface temperature varies irregularly in periods of the order of 200–1,000 days, about an average not far from the solar value of 6,000° K.

In 1939 this spectrum attracted attention at the Solar Physics Observatory, Cambridge, by the great strength of the Na *D* lines (as strong as in a normal *K2* star), although other features, such as lines due to ionized Fe, Ti, Sc, Ba, Si, Cr, etc., suggested a supergiant *G* or *F* star. Comparison with a typical supergiant *F5* spectrum (α Persei) showed approximately the same relative strength of Fe and Ti lines, while Na, Sc^+ and Si^+ were rather stronger in ρ Cassiopeiæ.

In 1946 Popper[1] announced that ρ Cassiopeiæ had faded by more than 1 magnitude to $6{\cdot}2^m$ and that its type had changed to *M* with the appearance of TiO absorption bands.

The Cambridge series was resumed in August 1946, plates being secured chiefly in the region *Hβ*–*Hα* with a dispersion of 60 A./mm. The series is necessarily discontinuous, but the best data refer to August, December, 1946, and April, 1947. Changes have taken place relatively slowly, the most marked having been noted between January and April, 1947, with the disappearance of TiO absorption and the accompanying brightening of the star to about mag. $5{\cdot}5^m$. The following are the chief facts noted in a spectrum that is remarkable for its complexity.

August 17, 1946. A remarkable phase showing TiO absorption bands of moderate strength, probably ScO, while YO is suspected. The spectrum in the region of 5300 A. is quite unlike a normal *M* star owing to the almost complete absence of Fe lines; it is suggested that this is due to superposed emission filling in the absorption, a phenomenon which is probably prevalent throughout the spectrum, thus rendering the residual absorptions extremely difficult to identify. Na *D* lines appear weakly in emission, 12 per cent above the continuous background (a rare phenomenon in stellar spectra apart from novæ); an extraordinary feature is that *D2* appears just resolved as a doublet (separation 1·7 A.) while *D1* is single. While other plates continue to show *D2* emission considerably broader than *D1*, the duplicity of *D2* is only shown clearly at this one epoch. Other emission lines are believed to be associated with neutral Ti lines.

August–December, 1946. Spectrophotometric measures show that the absorption at the TiO bandheads was slowly increasing. Na continued weakly in emission; absorption due to Ti, Ca, Cr, Ba, Ba^+, Sc^+, Y^+ identified. A plate in the *Hα* region on October 28, 1946, shows weak *Hα* emission and strong Si^+ absorption (characteristic rather of stellar spectra of type *A* than *M*).

April, 1947. Band absorption has nearly disappeared. Fe weakly present in absorption; Na emission has been entirely replaced by absorption

measured as 50 per cent stronger than that of 1939; strong absorption due to Sc^+ and Y^+ (Sc I also present but Y I undetectable). The region *D*–*Hα* bears a strong resemblance to that of the variables *VV* Cephei and μ Cephei, with Ba^+ 6495 remarkably strong, but the violet side of *D* is quite different, Sc^+ lines instead of TiO dominating the spectrum of ρ Cassiopeiæ.

Detailed studies of spectra like ρ Cassiopeiæ should throw important light on the problem of formation and dissociation of molecules at very low pressures (of the order of 10^{-4} atm. or less). The general character of the spectrum suggests an atmosphere with hydrogen rather less abundant than usual but plentiful oxygen. Some special explanation is required for the numerous lines of neutral Ti, while the tervalent atoms Sc and Y, of almost the same ionization potential, predominate in the singly ionized state. The answer may lie in the dissociation products of TiO, ScO and YO. Sponer[2] gives Ti (^3P) as a dissociation product of TiO, but the dissociation products of the other two molecules are apparently unknown. Several features in this stellar spectrum are in harmony with the hypothesis that the dissociation products of ScO and YO are $Sc^+(a^3P)$ and $Y^+(a^3P)$.

The origin of the doubling of *D*2 emission is unexplained. Possibly higher resolution would have revealed a similar doubling of *D*1, though the width of the lines does not suggest this. It is known[3] that very high electric fields can produce a splitting of *D*2 leaving *D*1 single; but in laboratory conditions the observed doubling would have involved a large shift to the red which is not observed in the stellar spectrum.

While the variations in magnitude may be explained, at least in part, as due to absorption by molecular clouds, the problem of whether such clouds are formed from matter ejected by the star or meeting it from outside also remains unsolved. It is, at any rate, clear that the strong Na absorption noted in 1939 is not due to generally dispersed interstellar sodium, since (*a*) high-dispersion plates revealed the presence of subordinate Na lines, (*b*) the subsequent Na emission could scarcely have been observed behind a dense absorbing cloud; there may, however, be a circumstellar cloud giving rise alternately to Na emission and absorption. The close passage of cometary or meteoric matter to the star's surface giving rise to Na, Fe emission (as has been observed in comets in the solar system) is a possibility to be borne in mind. The unusual strength of Si^+ lines is also consistent with the presence of stony meteorites.

Alternatively, it may be held that the star is passing through a critical stage in its internal evolution, while the molecular bands are due to ejected matter reaching densities characteristic of molecular formation[4].

In conclusion, it should be remarked that, despite the similarity to the binary *VV* Cephei, nothing in the observations of ρ Cassiopeiæ has as yet suggested a simple explanation in terms of two stars.

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June 19.

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[2] "Molecülspektren", **1**, 35 (Springer, 1935).
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Solar and Terrestrial Radio Disturbances

In their description of the solar radio emissions from the great sunspot of February 1946, Appleton and Hey[1] pointed out that a number of sudden enhancements of intensity, observed at about 5 metres wave-length, occurred simultaneously with increases in *D*-layer ionization as indicated by fade-outs on long-distance radio-communication circuits. This increased ionization, which is believed to be due to enhanced solar ultra-violet radiations, strongly absorbs the radio communication waves (of the order of 20 metres wave-length) but does not produce any marked absorption of the solar radio emissions at wave-lengths of 5 metres or less.

We have recently been making continuous recordings of radio noise at about 12 metres wave-length, using a half-wave dipole receiving aerial, and we have confirmed that at such a wave-length there is an unexpectedly high level of radio power from the galaxy, as first noted by Jansky[2]. Since the occurrence of enhanced *D*-layer ionization results in significant absorption at this wave-length, it is accompanied by a reduction in the received galactic radiation. If a burst of intense solar radio emission takes place simultaneously with the increased absorption, it is not easily possible to separate the two effects. On the other hand, there are occasions when the condition of simultaneity does not apply, as illustrated by the following examples.

On August 1, 1947, a sharp radio-communication fade-out commenced at approximately 15h. 16m. U.T. We are indebted to the Astronomer Royal for directing our attention to this epoch by informing us of a magnetic crochet in declination commencing at 15h. 16·7m. The recording of radio noise at 12 metres revealed that solar radio emissions were almost negligible compared with galactic radiations, which fell sharply in level at 15h. 16·8m., as shown in Fig. 1. The absence of solar radio emission on this occasion was confirmed by our recordings at shorter wave-lengths.

On June 14, 1947, a radio-communication fade-out commenced at about 10h. 36m. U.T. and was accompanied by a probable magnetic crochet at 10h. 36m. Recordings at 5 metres wave-length indicated a large burst of solar radio noise at about 10h. 40m. The observations at 12 metres wave-length, shown in Fig. 2, reveal both the commencement of the absorption at 10h. 36·2m. and the subsequent enhanced radio emission, the first large peak at this wave-length occurring at 10h. 39·2m.

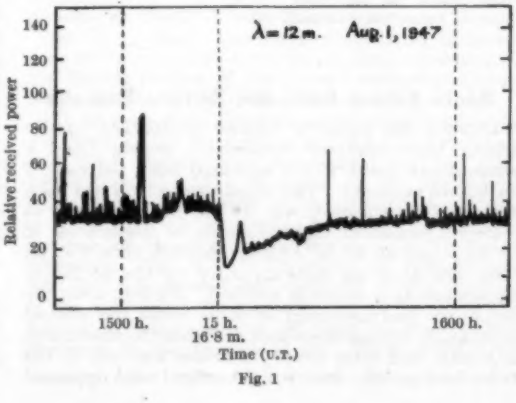

Fig. 1

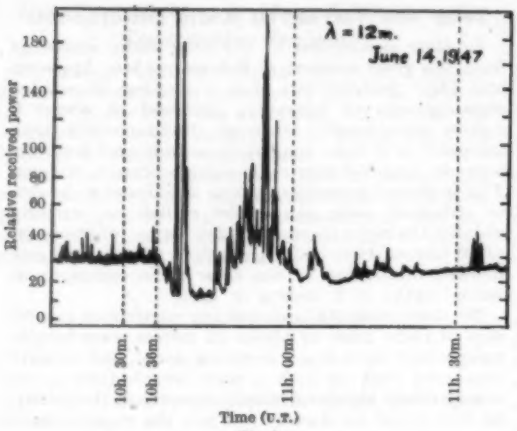

Fig. 2

It is thus evident that radio noise observations can be of special value in indicating *D*-layer ionization by the absorption effects on the galactic radio waves reaching the earth when solar radio emissions are small, or when the absorption precedes a solar radio burst. The time lag in the latter case might be interpreted as follows: the ultra-violet radiations giving rise to the enhanced *D*-layer ionization might be due to a solar disturbance travelling outwards from the sun, the electron density in the solar envelope being too great (see Saha[3], Martyn[4]) to allow radio-frequency waves to escape until the disturbance has reached the corona.

We wish to thank Sir Edward Appleton and Mr. H. W. Newton for their helpful suggestions and discussion. We are indebted to the Astronomer Royal for the information on magnetic crochets, to Cable and Wireless, Ltd., for the particulars of the radio fade-outs, and to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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Aug. 20.

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[2] Jansky, *Proc. Inst. Rad. Eng.*, **20**, 1920 (1932); **21**, 1387 (1933); **23**, 1158 (1935); **25**, 1517 (1937).
[3] Saha, *Nature*, **158**, 599 (1946).
[4] Martyn, *Nature*, **159**, 26 (1947).

Radio Echoes from the Aurora Borealis

During the night of August 15–16, 1947, radio echoes were obtained apparently arising from a luminescent cloud which appeared near the end of an aurora streamer. The apparatus, which has been described elsewhere[1,2], was in use for the study of meteoric ionization simultaneously on frequencies of 72 Mc./s. and 46 Mc./s. At Aug. 16d. 00h. 10m. U.T., an echo was observed intermittently on the 46 Mc./s. equipment at a range of 480 km. By 00h. 20m. the amplitude had increased to three times the normal noise-level. It then decreased with slow fluctuations in intensity, and after twenty minutes was lost in the noise-level at 00h. 30m. U.T. A second echo appeared at 460 km. range at 00h. 25m. U.T. and lasted for four minutes. Also at 00h. 10m. U.T., an increase in noise-level was apparent on both 72 and 46 Mc./s. equipments over the range 450–600 km. The noise increase persisted and increased in range to 700 km. by 00h. 35m. U.T., when it disappeared. Simultaneously with the appearance of the echoes, a faint blue-grey auroral cloud appeared near the zenith at the upper tip of one of the streamers, which were at that time covering the whole of the northern sky. The streamers receded from the zenith but the cloud grew in intensity, and at 00h. 35m. U.T. broke into nine striations and rapidly faded. The radio echoes thus vanished when the cloud became striated. The entire aurora was visible from darkness on August 15d. to August 16d. 02h. 30m. U.T., but apart from the effects recorded above no other unusual echoes were observed.

It may be assumed that this auroral cloud gave rise to an ionospheric type of radio echo rather than the scattering from a line source which is characteristic of the transient meteoric echoes. In this case the intensity of the ionization may be estimated, since the echoes were visible on the 46 Mc./s. equipment but not on 72 Mc./s. The critical frequency, therefore, lies within this frequency range. Applying the usual formula for the critical frequency[5]:

$$N = 1{\cdot}24 \times 10^{-8} f^2,$$

where N is electron density/c.c. and f is ordinary ray critical frequency in c./s., we obtain an ionization density in the range

$$2{\cdot}6 \times 10^7 - 6{\cdot}5 \times 10^7 \text{ electrons/c.c.}$$

This is about a hundred times greater than the normal ionization density in the *F*-region during the night.

The cause of the general noise increase from 450 to 700 km. observed on both frequencies may be due to the reflexion of the transmitted signal from a large number of subsidiary scattering points associated with the main cloud.

Since the auroral cloud was visible near the zenith, the measured range of 480 km. may be assumed to be the height of the cloud above the earth's surface. This height falls well within the range of aurora heights measured by Störmer from visible observations during the years 1911–44[6].

This appears to be the first record of reflexions from aurora on frequencies well above the critical *E*- and *F*-layer frequencies. It seems possible, however, that some of the sporadic *E*-layer effects found by workers in polar regions[7,8] may be cases of direct reflexion from the aurora forming in the 100 km. region.

These observations were made at the Jodrell Bank Experimental Station of the University of Manchester; lat. 53° 13′ 53″ N., long. 2° 18′ 11″ W.

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Aug. 31.

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[2] Lovell, Banwell and Clegg, *Mon. Not. Roy. Ast. Soc.*, in the press; see also *Nature*, **159**, 119 (1947) and **160**, 75 (1947).
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[4] Störmer, *Terr. Mag. and Atmos. Elect.*, 501 (Dec. 1946).
[5] For example, Appleton, Naismith and Ingram, *Phil. Trans.*, **236**, 191 (1937).
[6] Pierce, *Phys. Rev.*, **71**, 88 (1947).

INDUSTRIAL UTILIZATION OF AGRICULTURAL PRODUCTS AND SEAWEED

A COLLOQUIUM on "The Industrial Utilization of Agricultural Products and of Seaweed", organised by Cumann Ceimicidhe na hEireann (Irish Chemical Association) and the Dublin Section of the Royal Institute of Chemistry, was held in Dublin during July 2–3. The first chemistry conference to be held in Ireland, it was attended by chemists from all parts of that country as well as by a number from Great Britain.

The purpose of the colloquium was the examination of the present knowledge of the chemistry of various agricultural products and seaweed with the view of focusing attention on their potentialities as sources of raw materials for industrial purposes, and this aim was commended by the Tánaiste, Mr. Sean Lemass, Minister for Industry and Commerce, in his address when he formally opened the colloquium and welcomed the visiting speakers.

At the first session, which was devoted to a general survey of the subject, Dr. J. L. Simonsen, director of the Colonial Products Research Council, opened the proceedings with an address on "Agricultural Products and the Chemical Industry", in which he stressed the possibilities of sucrose as the basis of a new chemical industry on account of the fact that it may, with comparative ease, be converted into its octacetate, to its hydrogenation products mannitol and sorbitol, to the anhydrides of these, to lactic acid and to lævulinic acid, all of which substances have useful industrial applications. For example, the octacetate may be incorporated with laminated glass or with synthetic resins; sorbitol by microbiological oxidation can be converted to *l*-sorbose, which is the starting-point for the manufacture of vitamin C; the dehydration products of mannitol and sorbitol may be employed in the preparation of plasticizers and resins; lactic acid is used in the leather industry, and it also provides a convenient route to the preparation of acrylic esters; from lævulinic acid, substances which show promise of being of therapeutic value may be obtained, while the sodium salt of the acid is an 'anti-freeze' compound with significant advantages over other substances used for a similar purpose. A further variety of useful compounds may be obtained from sucrose by fermentation processes.

In the discussion which followed, Mr. W. V. Griffiths spoke on Irish fruits, the utilization of which in strictly chemical processes he considered likely to remain unimportant. Prof. G. T. Pyne dealt with industries based on casein and lactose, and Dr. H. Kennedy and Dr. H. A. Lafferty treated the subject from economic aspects.

"Seaweed" was the subject for the second session, and Prof. J. B. Speakman, professor of textile industries, University of Leeds, opened the discussion with a lecture on "The Production, Properties and Uses of Seaweed Rayon". After describing the extraction of alginic acid from seaweed, he gave an account of the work which led to the preparation of a calcium alginate solution suitable for spinning to fibre of a quality capable of being woven into fabric. This fabric goes into solution when washed in soap or soda; but the solubility of the calcium alginate fibre, at first so surely a damning feature, has been turned to such good account as to become its most valuable property. By embroidering on alginate fabric or incorporating alginate fibre with other fibres in various ways, weaving the resulting thread, and in each case eventually removing the alginate by washing, it has been possible to produce such materials as lace, fabrics which are self-sealing in rain or water, crêpes, artificial astrakhan and woollen cloth of extremely light texture. Prof. Speakman exhibited a large number of materials made by this ingenious 'disappearing thread' technique.

Prof. T. Dillon discussed the industrial possibilities of agar, carrageen mucilage and algin, Mr. D. T. Flood dealt with seaweed as a raw material in industry, Dr. T. Twomey described the processing of seaweed mucilages, and Mr. J. P. Twohig spoke on wool as an agricultural product, with special reference to its incorporation with seaweed-based rayon.

At the final session, with "Carbohydrates" as the subject, Prof. E. L. Hirst, director of the Chemical Laboratories, The University, Manchester, who has just been appointed to the new Forbes chair of organic chemistry at Edinburgh, speaking on "The Utilization of Carbohydrates", reviewed the more recent research work on cellulose, starch and sugar, and discussed the results obtained in relation to the possibilities of using these substances as raw materials. Degradation of cellulose from woody materials, by newer methods of hydrolysis, for the preparation of readily fermentable sugar solutions, would appear to lend itself to large-scale development. Potential new methods of utilization of starch, and the more exact control of existing manufacturing processes based on starch, become possible as a result of the newer knowledge of the starch granule. Uses may be found for each of the two structurally different major components, amylose and amylopectin, but large-scale separation of the granule into these requires further research. The interesting fact that the so-called 'waxy' starches, for example, waxy maize starch, contain amylopectin only, points to the possibility of the control of the composition of the starch granule by plant breeding. Sucrose, once the present supply difficulties have been overcome, can be considered as the starting point for an organic chemical industry because of the wide range of substances of industrial importance which can now be derived from it.

The contributors to the discussion were Dr. D. W. Kent-Jones, who gave information on the processing of flour for the preparation of amino-acids, Mr. G. A. C. Wilkin, who spoke on modern trends in the beet sugar industry, Dr. van der Lee, who discussed the industrial utilization of potatoes, and Mr. H. L. O'Reilly, who directed attention to the importance of some products of yeast fermentation.

Dr. V. C. Barry, president of the Irish Chemical Association, and Dr. A. G. G. Leonard, chairman of the Dublin Section of the Royal Institute of Chemistry, presided at the sessions.

There were three social events connected with the colloquium. On the evening of July 1, the members and their friends were entertained by the Irish Sugar Company at a reception in the Shelbourne Hotel, and provided with an opportunity of meeting in very pleasant circumstances before the serious business of the programme began. On Thursday afternoon, July 3, the President of Ireland and Mrs. O'Kelly showed their interest in the purpose of the colloquium by conferring on its members the honour of being received by them at their official residence in the Phœnix Park. There could have

been no more fitting conclusion to the activities than the 'party', consisting of a reception and dance, given by Imperial Chemical Industries, Ltd., in the Royal Hibernian Hotel on the evening of July 3; it was so thoroughly enjoyable as to make it certain that the visitors would carry away with them very happy recollections of their stay in Dublin.

G. F. O'SULLIVAN

DISPLACEMENT CHROMATOGRAPHY ON CATION-EXCHANGE MATERIALS

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IN recent years there have been many attempts to utilize the properties of the newer synthetic ion-exchange reagents for the separation of bases and amino-acids, but the application of truly chromatographic procedures has met with only partial success. In the course of the present investigation, it became clear that very sharp separations could be obtained on cation-exchange columns by the utilization of a strong base to displace others in the system. It was found that such a procedure could be reduced to the terms of the 'displacement development' principle introduced by Tiselius[1] for separations on adsorption columns of carbon or alumina, and for this reason we have made use of the theoretical background developed by this worker and his colleagues.

In essentials the method is as follows. The mixture of bases to be separated is introduced on to a column containing the cation-exchange reagent, and the components of the mixture are displaced down the column by the application of a solution of a base that is more strongly retained than the others in the mixture. In this way, once a flowing equilibrium has been established, the less strongly retained bases are successively displaced by bases having a stronger affinity for the ion-exchanger, and the components of the mixture pass down the column in a series of discrete bands, finally flowing from it in an order dependent upon the degree to which they are retained. In order to follow the changes in composition of the effluent, continuous measurements are made of two of the physical properties of the solution: electrical conductivity and hydrogen ion concentration.

In the present form of the apparatus, the adsorption column is of glass and is mounted in a 'Perspex' block. The block is accurately centred over an assembly consisting of a conductivity-cell, a valve for regulating the flow of liquid through the apparatus and a glass-electrode cell, all of which are made of 'Perspex'.

The behaviour of bases and ampholytes on the ion-exchange column may be expressed in the form of the familiar 'adsorption isotherm' in which the amount of substance adsorbed per gm. of adsorbent is plotted against the concentration of the solution. For the determination of such isotherms, a column is packed with a known weight of ion-exchanger, and a solution of the substance under test is passed through it. The effluent at first consists of pure solvent only, but when the retention front reaches the bottom of the column and a steady state is reached, the solution flowing from the column is of the same concentration as that supplied to it. The volume of pure solvent is characteristic for each solute and is termed the 'retention volume' (v). The weight of solute retained is then $v \times c$, where c is the concentration of the solution entering the column. If the column is initially wet with solvent, a small correction must be applied for the initial volume of solvent contained in it. The isotherms so determined are not necessarily identical with those determined by the classical methods, or with those calculated from titration curves, since a solution at constant concentration flows into the column at a finite rate. However, this method has been adopted, since the separation experiments are conducted under similar conditions.

The retention data in the curves of Figs. 1 and 2 refer to the cation-exchange resin 'Zeo-Karb. 215' (obtainable from the Permutit Co., Ltd., London). This was used as a sieved powder (80–100 mesh). In Fig. 1 the experimentally determined retention isotherms of a number of bases and amino-acids are shown.

The amount of base in millimols (ϵ) retained per gm. of 'Zeo-Karb.' (water content, 21 per cent) is plotted against the concentration in millimols per ml., with the exception of barium hydroxide, the isotherm of which is plotted in terms of milliequivalents instead of millimols. The gradients of the isotherms at low values of the concentration are very steep, and as the curves are in fact titration curves, they do not fit either the Freundlich or Langmuir equations. It was found that the amount of solute retained was independent of the rate of flow of the solution over a fairly wide range, and in most cases a rate of 70–100 ml. per hour was employed with columns 9 mm. in internal diameter.

A typical separation experiment is shown in Fig. 2. A mixture of 3·0 millimols of glycine and 3·4 millimols

Fig. 1

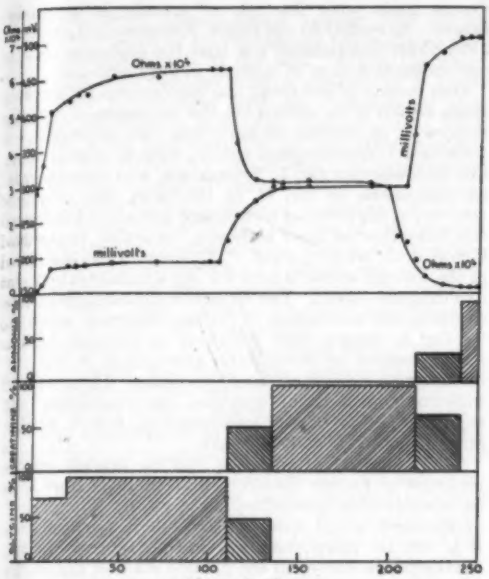

Fig. 2

of creatinine in 20 ml. water was run into the column. Two visible bands were formed, the lower of which was coloured dark reddish-brown (glycine) and the other yellowish-orange (creatinine). The column was then washed with water to remove anions present as impurities. Finally, 0·043 *M* ammonia solution was used as the displacement developer. A volume of 140 ml. of ammonia solution was passed into the column before the *p*H and resistance of the effluent changed from that of the distilled water used. The lower band of glycine then emerged from the column, followed by the next band (creatinine), the two bands overlapping as shown in the lower half of Fig. 2. Finally, the ammonia band emerged, the front overlapping with the tail of the creatinine band. In the figure the volume of effluent (abscissæ) is plotted against the concentration of solute (ordinates) from the time at which the first change in *p*H and resistance occurred. The concentration is expressed as a percentage of the expected concentration calculated from the retention isotherms. This concentration (the equilibrium concentration) is readily obtained by the graphical method of Claesson[2]; a straight line is drawn from the origin to the point on the isotherm of the developer, corresponding to a concentration of 0·043 *M*. The intersection of this straight line on the corresponding isotherms of glycine and creatinine then gives the concentration at which these components will emerge from the column.

The volume-concentration curves for the glycine, creatinine and ammonia fractions are plotted separately in the figure as histograms, the base of each rectangle representing the volume of the fraction taken for chemical analysis. In the upper half of the figure, the *p*H (mV.) and the resistance (in ohms × 10^4) (ordinates) are plotted against the volume of effluent (abscissæ). It will be seen that these curves give a very clear indication of the actual concentration-changes in the effluent. Chemical analysis of the fractions showed that 87·5 per cent of the total glycine and 73·0 per cent of the total creatinine were recovered pure. The total recovery of glycine and creatinine was respectively 98 and 103 per cent.

In the experiment described above, the solutes were displaced in order of their ε-values, glycine ($\varepsilon = 1{\cdot}81$) emerging first, followed by creatinine ($\varepsilon = 2{\cdot}20$) and ammonia ($\varepsilon = 2{\cdot}88$). Reference to the table, however, shows that this order is not the rule. The ε-values of the various bases or amino-acids are quoted at the equilibrium concentration at which they emerge when displaced with 0·10 *N* barium hydroxide.

RETENTION DATA OF A NUMBER OF BASES AND AMINO-ACIDS ON 'ZEO-KARB. 215'

Substance	Equilibrium concentration (*c*) (millimols/ml.)	ε	*p*H of emerging solution
½Ba(OH)₂	0·1	5·45	12·72
NaOH	0·071	8·87	12·85
NH_4OH	0·055	3·00	11·00
Anserine	0·035	1·91	8·27
Carnosine	0·035	1·91	8·17
Creatinine	0·041	2·23	8·17
Creatine	0·037	2·02	7·00
Glycine	0·033	1·80	5·97
Glutamic acid	0·0325	1·77	3·22
Aspartic acid	0·023	1·25	2·77

In the table, the bases are arranged in the order in which they displace one another, and the displacement is seen to be in ascending order of the *p*H values given by the emerging components. Thus, although creatinine and creatine have higher ε-values than anserine, the latter displaces them from the column. In the table the brackets include substances which do not separate completely on short columns.

Experiments carried out using longer columns and more complex mixtures have given encouraging results, and the technique shows promise as a method of general application for the isolation of amino-acids and bases.

This work forms part of the programme of the Food Investigation Board of the Department of Scientific and Industrial Research.

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[2] Claesson, S., *Ark. Kem. Min. Geol.*, **23 A**, No. 1 (1946).

CHEMICAL CARCINOGENESIS

THE discovery and development of cancer-producing chemical compounds represent a major achievement of cancer research in Britain, although many important contributions have been made in other countries, notably in Japan and in the United States. It is therefore peculiarly appropriate that the British Council should sponsor the publication of an excellent and comprehensive series of articles reviewing the whole field of chemical carcinogenesis*. There are papers by twenty authors from eleven different research centres, representing the main fields of cancer research activity in the United Kingdom. This symposium ranks in importance with, and supplements, the symposium on cancer research published in 1945 by the American Association for the Advancement of Science (see *Nature*, **158**, 217; 1946). The planning of the British Council's publication was carried out with the advice of Prof. Alexander Haddow, who has himself contributed three interesting articles, one of them in collaboration with Prof. G. A. R. Kon. "Its intention is not merely to provide

* This is the general title of a series of articles which comprise a special number of the *British Medical Bulletin* (**4**, Nos. 5–6; 1947).

a conspectus of our present knowledge, but to indicate also the probable trends of development for the years ahead."

The articles are classified under seven sub-headings; namely, nature of carcinogenic compounds; mechanism of carcinogenesis; metabolism of carcinogenic compounds; carcinogens of biological origin; remote carcinogenic action; occupational cancer; chemotherapy of cancer. They are based on research carried out with the support of the British Empire Cancer Campaign, to which acknowledgment is justly made as having achieved more than any other single body towards advancing the study of cancer in Britain. This in no way obscures the valuable part played by the Imperial Cancer Research Fund and many of the voluntary hospitals, or the generous financial support given to British research centres from American sources, such as the International Cancer Research Foundation, the Anna Fuller Fund, and the Jane Coffin Childs Memorial Fund.

There is little doubt that the greatest promise of a final solution to the social as well as the scientific problems of cancer lies in a full understanding of the nature and causes of malignant growth and of the conditions which promote it. So far as can be judged at present, there are two main avenues by which these objectives may be approached. One is concerned with the study of chemical carcinogenesis, and the other with the induction and transmission of tumours by viruses. It is interesting that whereas the discovery of chemical carcinogenesis was primarily a British achievement, the three major discoveries in connexion with virus tumours were made in the United States. These are concerned with the viruses of the Rous chicken sarcoma and the Shope papilloma of the cotton-tail rabbit, and the 'milk factor' in mammary carcinoma of mice, discovered by Bittner. The chemical and the virus methods of investigating the causation of cancer are complementary, and in his article on the mode of action of carcinogens Haddow has attempted a synthesis of the two. His speculations are based on recent advances in cell physiology which have emphasized the importance of the cytoplasm, as distinct from the cell nucleus, in cell growth and heredity.

The subject of chemical carcinogenesis may be said to have originated in the clinical observations of Percivall Pott, published in 1775, on chimney sweep's cancer. Pott was a surgeon at St. Bartholomew's Hospital, and his clear-sighted deductions as to the role of soot in the disease which he described had their final consummation in the researches carried out and inspired by E. L. Kennaway at the Royal Cancer Hospital, leading to the discovery of the carcinogenic properties of polycyclic aromatic hydrocarbons. By common consent, Sir Ernest Kennaway is acknowledged as the outstanding British cancer research worker of the present century, and to have been a member of his team is the greatest privilege that has fallen to the lot of the present writer. There is a certain fitness in the circumstance that Kennaway has gone to work, during his years of retirement, in the same hospital in which his distinguished prototype, Percivall Pott, did his pioneer work. The intimate association between the various forms of industrial cancer and the experimental cancer due to chemical compounds is recalled by three articles in the symposium under discussion. Dr. S. A. Henry gives a review, with illustrations and statistics, of occupational skin cancer; Dr. M. W. Goldblatt discusses occupational cancer of the bladder; and Dr. A. N. Currie deals with the role of arsenic in industrial cancer. In regard to the latter, Kennaway (*Lancet*, ii, 769; 1942) has pointed out that the evidence for the carcinogenic action of arsenic is very slender.

One means of studying the mechanism of carcinogenic action is to determine the influence of various factors in promoting or retarding the production of tumours. Cocarcinogenic agents, such as croton resin, are discussed by Dr. I. Berenblum, and inhibitors of carcinogenesis by Mr. H. G. Crabtree, who gives an account of the effect of nutritional factors in inhibiting the induction of liver tumours. Another important factor, dealt with by Prof. F. Dickens, is the influence of the solvent which is used for the administration of a carcinogenic agent. The evidence for the presence of carcinogenic substances in human tissues is analysed by Dr. I. Hieger, and attention is directed by Dr. P. R. Peacock to the possible conversion of fats into carcinogens during cooking processes. These are all important aspects of chemical carcinogenesis, and represent some of the directions in which further efforts should be concentrated.

The upheaval of war has had its impact on the progress of cancer research, and there is now need for considerable intensification of effort. The present symposium would serve an invaluable purpose even if it did no more than provide an interesting and authoritative survey of the present state of knowledge in an important branch of cancer research for a new generation of scientific workers, of whom some may be attracted to work on this intriguing and elusive problem.

J. W. Cook

DIFFUSION OF DISSOLVED SUBSTANCES THROUGH THALLI AND LEAVES OF AQUATIC PLANTS

By Prof. E. STEEMANN NIELSEN
Botanical Department, Danish Pharmaceutical Highschool

So far as I know, there is no information in the literature as to the rate of diffusion of dissolved substances through plant tissues. With animal tissues such investigations have been made, for example, by Krogh[1]. Of course, botanists have been interested in the problem of diffusion, but it has been tackled differently. Instead, investigations have been made as to how the various substances enter the cells. It is the so-called permeability that has been determined. It is, however, impossible to obtain any values for the rate of diffusion through the cells by this method.

Diffusion is due to differences in concentration and follows the so-called Fick's law. If the concentration (mol./l.) in two layers at a distance of 1 cm. from each other is C_1 and C_2 ($C_2 > C_1$), there will be through A cm.^{2} in t times 24 hr. a diffusion of an amount Q (in mols.) $= k \times \frac{C_2 - C_1}{l} \times A \times t \times 10^{-3}$, where k is a coefficient dependent on the substances and the temperature, the diffusion coefficient.

In what follows, the word 'diffusion' is used in a wider sense than commonly. For a substance like oxygen it is only to be kept in mind that the concentration gradient, because of the cytoplasmic membranes, is not even through the plant. When salts

are used, more complications appear, first of all because the plant in all probability takes active part in the transportation of the salt. When the plant is brought into contact with a solution of a single salt, there is probably first an exchange of ions between the solution of the salt and the plant. This, however, is not important for the present determinations of the 'diffusion', as the series of experiments were of long duration (some hours). The amount of ions passing through the plant is of quite a different order of magnitude from the amount of ions present at the start of the experiment. This is also the case when low concentrations of a single salt are used. Furthermore, one gets constant values in series of experiments. This indicates constant conditions in the plant during the experiments.

An apparatus for the investigation of the diffusion through leaves and thalli was constructed. Two round glass cylinders open at both ends (thickness of the wall, 2·5 mm.) and with plane-ground edges each had a content of 15 ml., the area of the opening being 3 cm.². A thallus of an alga or a leaf of a higher aquatic plant was placed between the two cylinders, which by means of rubber bands fastened to metal mountings were pressed together. A protective layer of paraffin was placed outside. On both sides of the leaf or thallus it was now possible to place water with different contents of the substances the diffusion of which through the leaf or thallus it was intended to investigate.

The cylinders were closed by means of plane-ground glass plates kept in their places by strong rubber bands. The cylinders then were placed in a water thermostat on a horizontal axis which was rotating two hundred times a minute. In each of the cylinders a glass rod was placed. Thus a vigorous stirring on both sides of the leaf took place.

TABLE 1. THE DIFFUSION COEFFICIENT AT 20° C. IN WATER AND IN *Ulva lactuca* (SEA-WATER IS USED)

	Water	*Ulva*
O_2	1·80	0·29 ± 0·01
NaCl	1·10	0·054 ± 0·001
$NaHCO_3$	about 1	0·029 ± 0·001

A thallus of the green alga *Ulva lactuca* is particularly suitable, as there are only two layers of cells and no intercellular spaces in the thallus. The thickness of the thallus is about 0·035 mm. In Table 1 the coefficients of diffusion of O_2, NaCl and $NaHCO_3$ in water and in an *Ulva* thallus are set out (20° C.). The coefficients of diffusion in water are taken from Landolt-Börnstein[2]. An increase of the diffusion coefficient of 3 per cent per degree C is allowed for. Thus the rate of diffusion of O_2 is reduced to about 1/6 in the thallus. The rates of diffusion of the salts NaCl and $NaHCO_3$ are reduced to about 1/20 and 1/30 in the thallus. At an experiment with a leaf of *Potamogeton lucens* at 20° C. a diffusion coefficient of 0·010 for the HCO_3^- ions was found. The rate of this diffusion is of great importance for our understanding of photosynthesis on the basis of bicarbonate ions. In the literature it is stated (Osterhout and Dorcas[3]) that bicarbonate ions cannot penetrate into the cells of aquatic plants, a statement which thus is not correct.

TABLE 2. THE DIFFUSION COEFFICIENT OF O_2 AT 20° C. THROUGH A LEAF OF *Cryptocoryne Griffithii* WHEN EITHER LAKE-WATER OR A PURE SOLUTION OF NaCl (0·4 gm./l.) IS USED

Lake water	0·77 ± 0·05
NaCl solution	0·75 ± 0·03

The rate of diffusion of electrically neutral particles such as oxygen is independent of the ion composition of the water (Table 2). At high concentration of a single salt the diffusion coefficient for this salt increases greatly, and the plant (also marine plants) dies after some time. At all investigations of salt diffusion through plants previously described, balanced water was used, that is, water which besides the salt in question contains a great number of other ions.

If there is only one salt present, and only in concentrations of the order of magnitude 10^{-2}–10^{-3} mol./l., the rate of diffusion of this salt through a leaf or thallus is considerably reduced (Table 3). Hence it is clearly shown that the intensity of photosynthesis with HCO_3^- as C-source—but not with free CO_2 as C-source—is highly dependent on the ion composition (Steemann Nielsen[4]). In a pure $KHCO_3$ solution (10^{-3} mol./l.) the photosynthesis in *Myriophyllum spicatum* at optimal light at 20° C. is only 42 per cent of that in lake-water with the same HCO_3^- concentration.

TABLE 3. THE DIFFUSION COEFFICIENT OF NaCl AT 20° C. THROUGH A LEAF OF *Cryptocoryne Griffithii*

Balanced salt solution (10^{-2} equiv. Cl^-/l.)	0·076 ± 0·004
Pure NaCl solution (10^{-2} equiv. Cl^-/l.)	0·047 ± 0·002

I have investigated the rate of diffusion of NaCl through a thallus of *Ulva lactuca*, partly in light (37·000 lux), partly in the dark. If there is any difference at all it is, at any rate, rather insignificant.

I have not, it is true, succeeded in determining the coefficient of the diffusion of free carbon dioxide through a submerged leaf or a thallus. Various technical difficulties have prevented me. If, however, it is assumed that animal and vegetable tissue in principle behave in the same way, it is possible to determine approximate values for the coefficient of the diffusion of CO_2 through leaves and thalli.

Krogh showed that CO_2 and O_2 in animal tissue diffuse in nearly the same mutual ratio as in water. At 20° C. the diffusion coefficient for O_2 dissolved in water is 1·80, that of CO_2 1·55. In a thallus of *Ulva lactuca* at 20° C. the diffusion coefficient for O_2 is 0·29. The corresponding value for CO_2, therefore, may approximately be put at $\frac{0{\cdot}29 \times 1{\cdot}55}{1{\cdot}80} = 0{\cdot}25$.

In *Ulva* the diffusion coefficient for bicarbonate in balanced solution was determined at 0·029. CO_2 thus diffuses through an *Ulva* thallus about nine times as fast as HCO_3^-, and hence free CO_2 may at low concentrations be expected to give nine times as high photosynthetic intensity as HCO_3^- in the same concentration.

My experiments with *Myriophyllum spicatum*[4] in small quantities of free carbon dioxide give about five times as great photosynthetic output as the corresponding quantity of HCO_3^-. As shown by Arens[5], and confirmed in my investigations during photosynthesis with HCO_3^- ions as C-source, OH^- ions are produced which, either free or bound to some compound, pass one-sidedly towards the upper side of the leaf, where they are liberated together with equivalent quantities of cations. This transport of OH^- ions is not a diffusion process.

A full account of this work will appear later in *Dansk Botanisk Arkiv*.

[1] Krogh, A., *J. Physiol.*, **52** (1919).
[2] Landolt-Börnstein, "Physikalisch-Chemische Tabellen" (Berlin, 1923–36).
[3] Osterhout, W. J. V., and Dorcas, M. J., *J. Gen. Physiol.*, **9**, 255 (1926).
[4] Steemann Nielsen, E., *Nature*, **156**, 594 (1946).
[5] Arens, K., *Jahrb. wissensch. Bot.*, **83**, 513 (1936).

FORTHCOMING EVENTS

Tuesday, September 16

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Baron Christoph von Fürer-Haimendorf: "Culture Strata in the Deccan".

Wednesday, September 17

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (joint meeting with the LONDON BRANCH OF THE INSTITUTE OF WELDING, at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Mr. W. K. B. Marshall: "Recent Advances in the Welding of Plant for the Chemical Industry".

Tuesday, September 16—Wednesday, September 17

INSTITUTE OF PHYSICS, ELECTRON MICROSCOPY GROUP (in the Physics Department, The University, Leeds).—Conference on "Electron Microscopy".

Friday, September 19

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5.30 p.m.—Mr. D. H. Sadler: "The Navigational Work of the Nautical Almanac Office": Capt. E. Brook Williams: "Wind Statistics and their Application to Air-line Operation".

Saturday, September 20—Sunday, September 21

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at the London School of Economics, Houghton Street, London, W.C.2).—Twenty-second Annual Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ANALYST (Mineral Nutrition of Plants and Soils)—The Secretary, Long Ashton Research Station, Long Ashton, Bristol (September 20).

LABORATORY TECHNICIAN FOR SURGICAL UNIT at Cardiff Royal Infirmary—The Secretary, Medical School, 10 The Parade, Cardiff (September 20).

COMPUTER IN THE DEPARTMENTS OF ENGINEERING for a mathematical investigation in the field of Electronics—The Registrar, The University, Sheffield (September 27).

ASSISTANT LECTURER IN CHEMICAL ENGINEERING—The Registrar, The University, Leeds 2 (September 27).

PROFESSOR OF GEOGRAPHY, a PROFESSOR OF CHEMISTRY, and a SENIOR LECTURER IN CHEMISTRY, at Raffles College, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (September 30).

PHYSICIST IN THE RADIOTHERAPY DEPARTMENT—The Superintendent, Glasgow Royal Infirmary, 84 Castle Street, Glasgow, C.4 (September 30).

SCIENTIFIC OFFICER to act as Assistant to the Director of Scientific Development in the Ministry of Commerce—The Secretary, Civil Service Commission, Stormont, Belfast (October 15).

LECTURER IN THE DEPARTMENT OF PATHOLOGY—The Secretary and Bursar, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (October 15).

DYE CHEMIST by the Government of Nigeria for a Peasant Textile Industries Development Scheme—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.14900.

FOREST PRODUCTION OFFICER by the Government of Sierra Leone—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.18352.

CHEMISTS, (1) SENIOR SCIENTIFIC OFFICER to take charge of the chemical research on fundamental and applied aspects of the problem of marine fouling of ships and the development of counter-measures, (2) SCIENTIFIC OFFICER to work on physico-chemical and paint problems in connexion with the above programme; and a BIOLOGIST (graduate in zoology) for work in connexion with the above programme—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

LECTURER IN BOTANY AND GENERAL BIOLOGY—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan.

ASSISTANT PHYSICIST—The Secretary, Sheffield National Centre for Radiotherapy, Broom Cross, Tree Root Walk, Sheffield 10.

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Aberdeen.

RESEARCH AND MEDICAL RECORDS LIBRARIAN IN THE DEPARTMENT OF PATHOLOGY—Dr. A. H. T. Robb-Smith, Department of Pathology, Radcliffe Infirmary, Oxford.

RESEARCH ASSISTANT for work on noise problems—The Secretary, Motor Industry Research Association, Great West Road, Brentford, Middx.

JUNIOR ORGANIC CHEMISTS—The Secretary, British Rubber Producers' Research Association, 19 Fenchurch Street, London, E.C.3.

MECHANIC for Laboratory Workshop, and a TECHNICIAN IN THE DEPARTMENT OF ANATOMY—The Establishment Officer, University College London, Gower Street, London, W.C.1, quoting Anatomy/Mechanic.

LABORATORY TECHNICIANS (male) in chemical and bio-chemical research laboratories—The Administrative Officer, National Institute for Medical Research, Hampstead, London, N.W.3.

LABORATORY TECHNICIAN (Grade B)—The Superintendent and Secretary, Kent and Canterbury Hospital, Canterbury.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Annual Reports for 1941–44 (Nos. 54–57) of the Marine Biological Station at Port Erin, Isle of Man. Drawn up for Prof. J. H. Orton by J. R. Bruce. Pp. 28. (Liverpool: University Press of Liverpool, 1946.) 3s. net. [213

Imperial Bureau of Pastures and Forage Crops. Bulletin 37: The Forage Resources of Latin America—Peru. By Hugo W. Alberts. Pp. 24. (Aberystwyth: Imperial Agricultural Bureaux, 1947.) 2s. 6d. [213

Board of Control (England and Wales). Pre-Frontal Leucotomy in 1000 cases. Pp. 32. (London: H.M. Stationery Office, 1947.) 6d. net. [213

Oxford Forestry Memoirs. No. 20: The Natural Vegetation of Trinidad. By Dr. J. S. Beard. Pp. 152 + 14 plates. (Oxford: Clarendon Press: London: Oxford University Press, 1946.) [213

Amgueddfa Genedlaethol Cymru: National Museum of Wales. The Slates of Wales. By Dr. F. J. North. Third edition. Pp. viii + 121 + 18 plates. (Cardiff: National Museum of Wales, 1946.) 5s. [213

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute. Report on the Work of the School for the Year 1945–46. Pp. 83. (London: London School of Hygiene and Tropical Medicine, 1947.) [243

Annual Report of the Oundle School Natural History Society. Pp. 31. (Oundle: Oundle School, 1947.) [243

Linen Industry Research Association. Report of the Council, 1946. Pp. 24. (Lisburn: Linen Industry Research Association, 1946.) [243

Annual Report and Transactions of the Yorkshire Philosophical Society for the Year 1945. Pp. 43. (York: Yorkshire Museum, 1946.) [273

Brainy Britons and Brainless Britain: a Ruthless Examination of our National Institutions and a Programme for a 20th Century Renaissance. By W. Margrie. Pp. 8. 6d. My Seventy Years: the Struggles and Adventures of a Pioneer, a Fight against Apathy and Moral Cowardice. By W. Margrie. Pp. 8. 6d. (London: The Author, 24 Nigel Road, S.E.15, 1947.) [273

Other Countries

Annals of the New York Academy of Sciences. Vol. 46, Art. 10: Brain and Body Weight in Man, their Antecedents in Growth and Evolution; a Study in Dynamic Somatometry. By Earl W. Count. Pp. 993–1122. 2 dollars. Vol. 48, Art. 5: Folic Acid. By Y. Subba Row, Robert B. Angier, Nestor Bohonos, James H. Boothe, Mary C. Clark, Donna B. Cosulich, Raymond W. Cunningham, Floyd S. Daft, M. J. Fahrenbach, Ben King Harned, Robert W. Heinle, M. E. Hultquist, Brian L. Hutchings, Erwin Kuh, John H. Mowat, Evelyn M. Nelson, H. V. Nelson, E. H. Northey, W. H. Peterson, Doris R. Seeger, Joseph Semb, J. P. Sickels, Nathan Sloane, Helen D. Smith, James M. Smith, Jr., Tom D. Spies, E. L. R. Stokstad, John R. Trotter, Coy W. Walter and Arnold D. Welch. Pp. 255–350. 1.50 dollars. (New York: New York Academy of Sciences, 1946.) [173

Government of Madras: Education and Public Health Department (Education). Administration Report of the Government Museum and Connemara Public Library, Madras, for the Year 1945–46. Pp. ii + 14. (Madras: Government Press, 1946.) [173

Developing Village India: Studies in Village Problems. (*Indian Farming* Special Number.) Pp. xvi + 291 + 118 plates. (New Delhi: Imperial Council of Agricultural Research, 1946.) [173

Commonwealth of Australia: Department of Commerce and Agriculture, Commonwealth Fisheries Office. Economic Report No. 1: Pearl Shell, Beche-de-Mer and Trochus Industry of Northern Australia. Pp. xiii + 104 + 27 plates. (Sydney: Government Printer, 1946.) [173

Bernice P. Bishop Museum. Bulletin 188: Report of the Director for 1945. By Peter H. Buck (Te Rangi Hiroa). Pp. 38. Bulletin 189: Insects of Guam, II. Pp. v + 237. (Honolulu: Bernice P. Bishop Museum, 1946.) [173

U.S. Department of Agriculture. Leaflet No. 152: How to Control Fleas. By F. C. Bishop. Revised edition. Pp. 4. (Washington, D.C.: Government Printing Office, 1946.) [173

Occasional Papers of the Bernice P. Bishop Museum. Vol. 18, No. 11: Leeches (Hirudinea) from the Hawaiian Islands, and Two New Species from the Pacific Region in the Bishop Museum Collection. By J. Percy Moore. Pp. 171–192. Vol. 18, No. 12: New Amblycnemus from the Philippines, Borneo and Java (Coleoptera, Curculionidae). By Elwood C. Zimmerman. Pp. 193–198. Vol. 18, No. 13: New Genera and Species of Synceridae from Ponape, Caroline Islands. By William J. Clench. Pp. 199–206. Vol. 18, No. 14: Additions to the Flora of the Manua Islands. By T. G. Yuncker. Pp. 207–210. Vol. 18, No. 15: Dispersal of Shipworms among Central Pacific Islands, with Descriptions of New Species. By Charles Howard Edmondson. Pp. 211–224. Vol. 18, No. 16: The Genus *Peperomia* in the Galapagos Islands. By T. G. Yuncker. Pp. 225–234. Vol. 18, No. 17: Hawaiian Tattooing. By Kenneth P. Emory. Pp. 235–270. Vol. 18, No. 18: Reproduction in *Donatia deformis* (Thiele). By Charles Howard Edmondson. Pp. 271–282. Vol. 18, No. 19: Behavior of Coral Planulae under Altered Saline and Thermal Conditions. By Charles Howard Edmondson. Pp. 283–304. (Honolulu: Bernice P. Bishop Museum, 1946.) [173

Analytica Chimica Acta. Editor: Paul E. Wenger. Vol. 1, No. 1, January. Pp. 72. (New York and Amsterdam: Elsevier Publishing Co., Inc., 1947.) 9.50 dollars a year. [173

Biochimica et Biophysica Acta. Vol. 1, No. 1, January. Pp. 100. (New York and Amsterdam: Elsevier Publishing Co., Inc., 1947.) 9 dollars a year. [173

Pioneering in Television: Prophecy and Fulfilment. Excerpts from Speeches and Statements by Brig.-General David Sarnoff. Pp. 99. (New York: Radio Corporation of America, 1946.) [183

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 96, No. 4: Studies of South American Psammocharidae, Part 1. By Nathan Banks. Pp. 309–520 + 3 plates. (Cambridge, Mass.: Harvard College, 1946.) [183